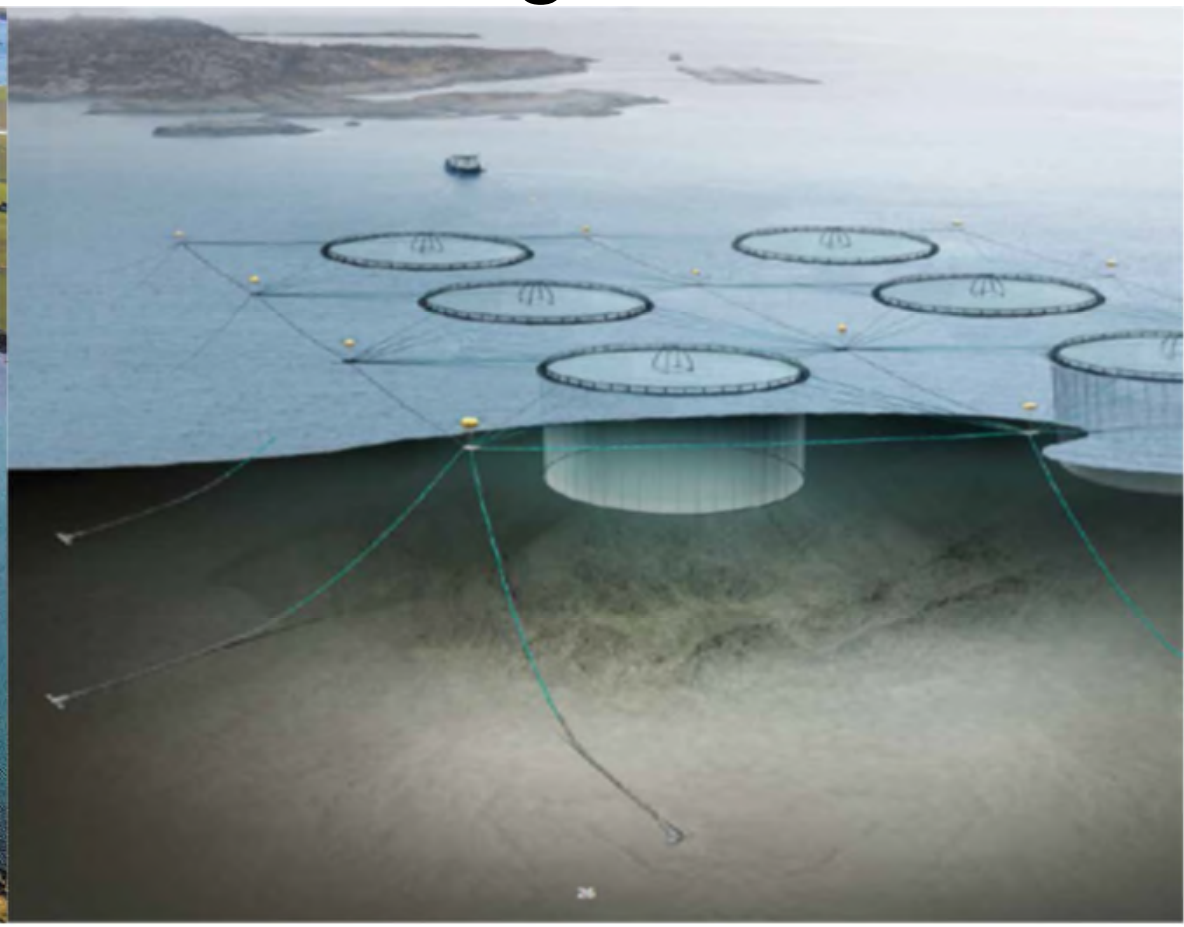
Aquaculture Modelling



Alan Hills & Andrew Berkeley

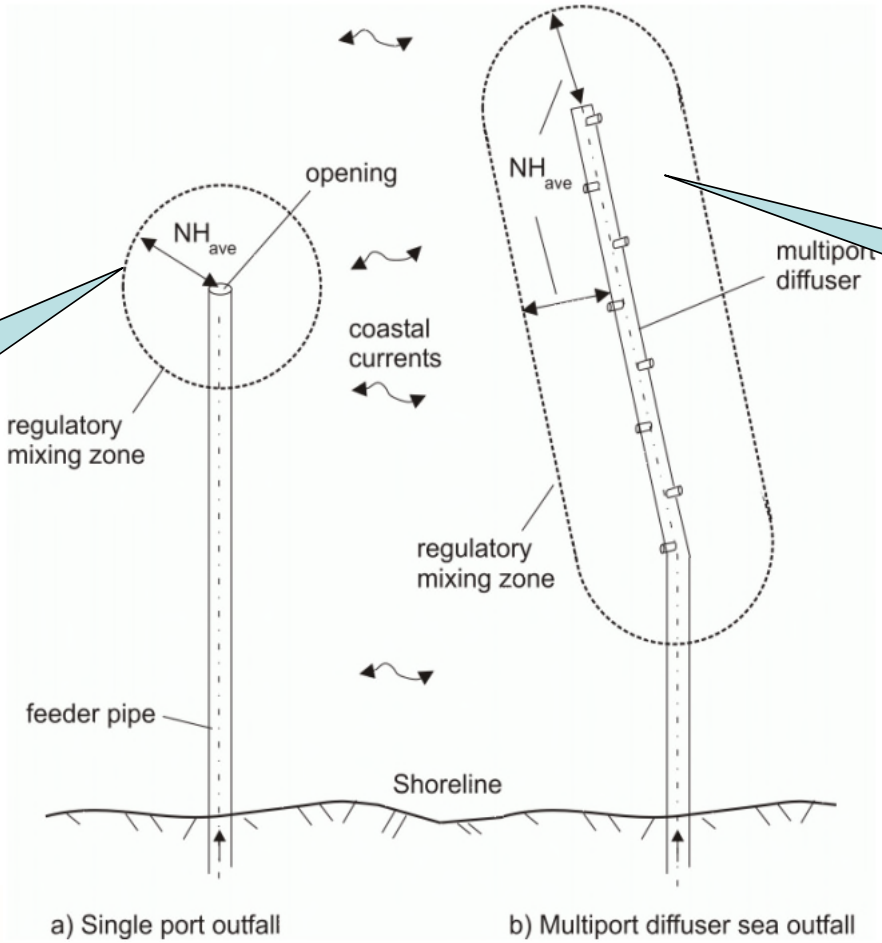
SEPA
Scottish Environment Protection Agency

Presentation Structure

- Review Some Key Concepts
- Proposed New Modelling Workflow – What's New?
- Introduce Screening Modelling
- Update on Depomod
- Marine Modelling/Bath Treatment Modelling
- Application Modelling Requirements
- Summary of Key Points

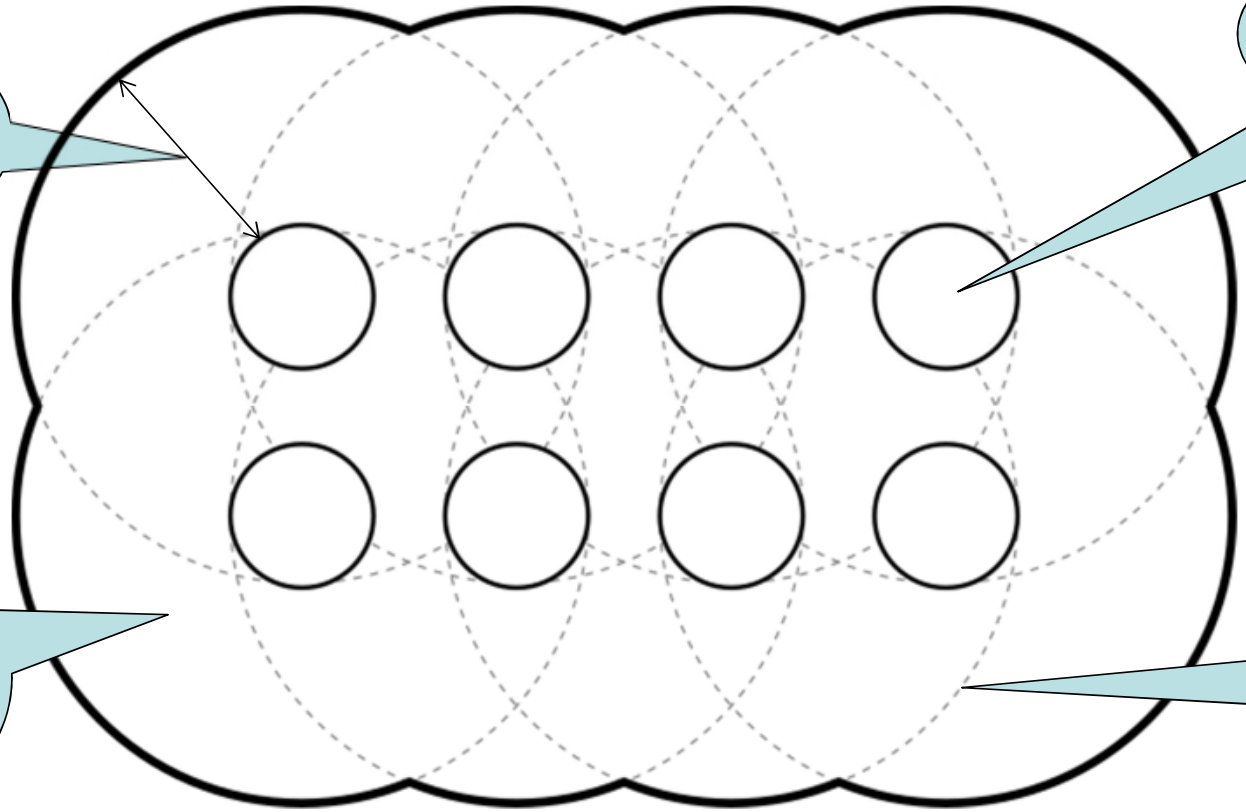
Key Concept – Mixing Zone

100 m Radius Mixing Zone For Marine Outfalls



Chronic Impacts Allowed Within Mixing Zone

Key Concept – Mixing Zone - Aquaculture



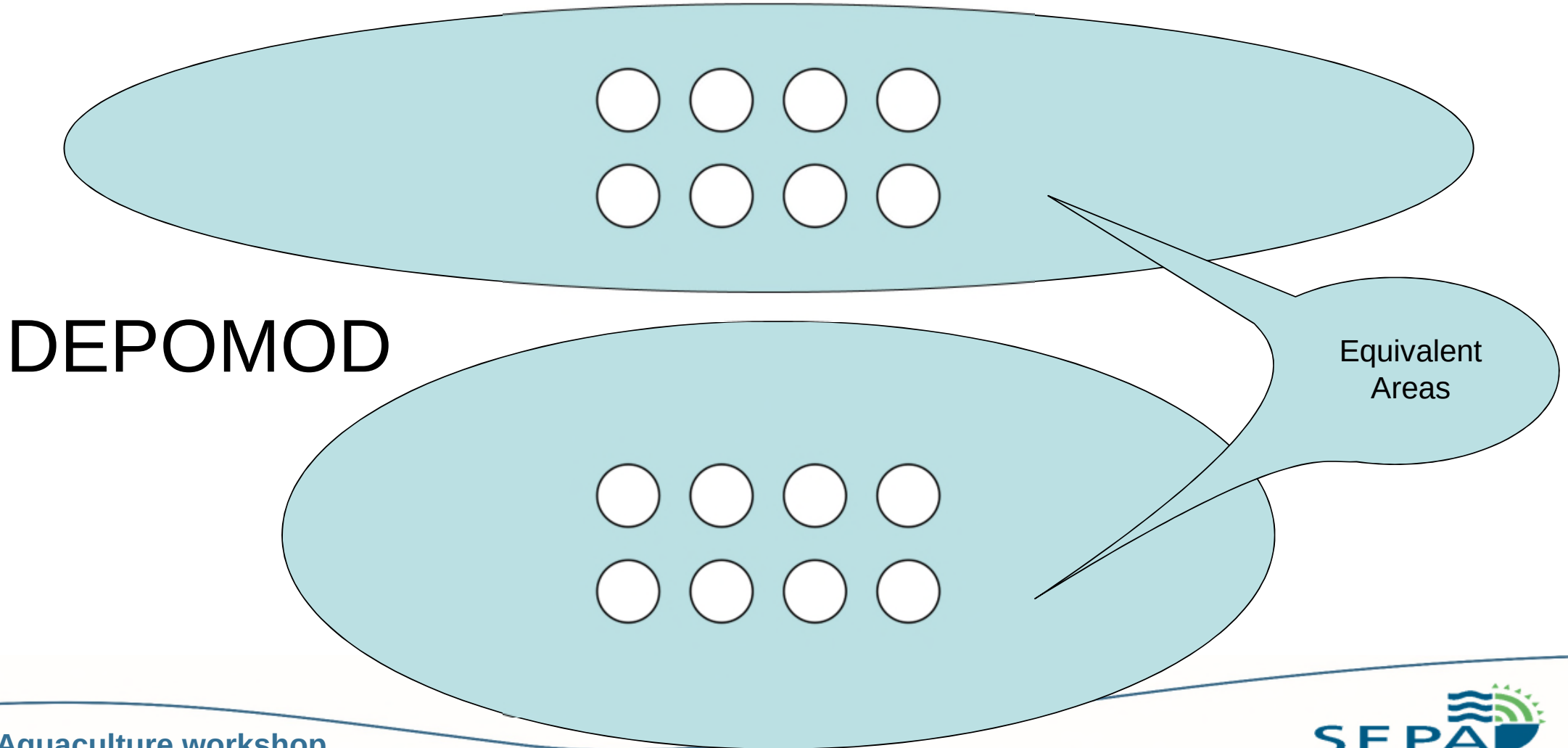
100 m From Farm Cage Edge

Farm Cage

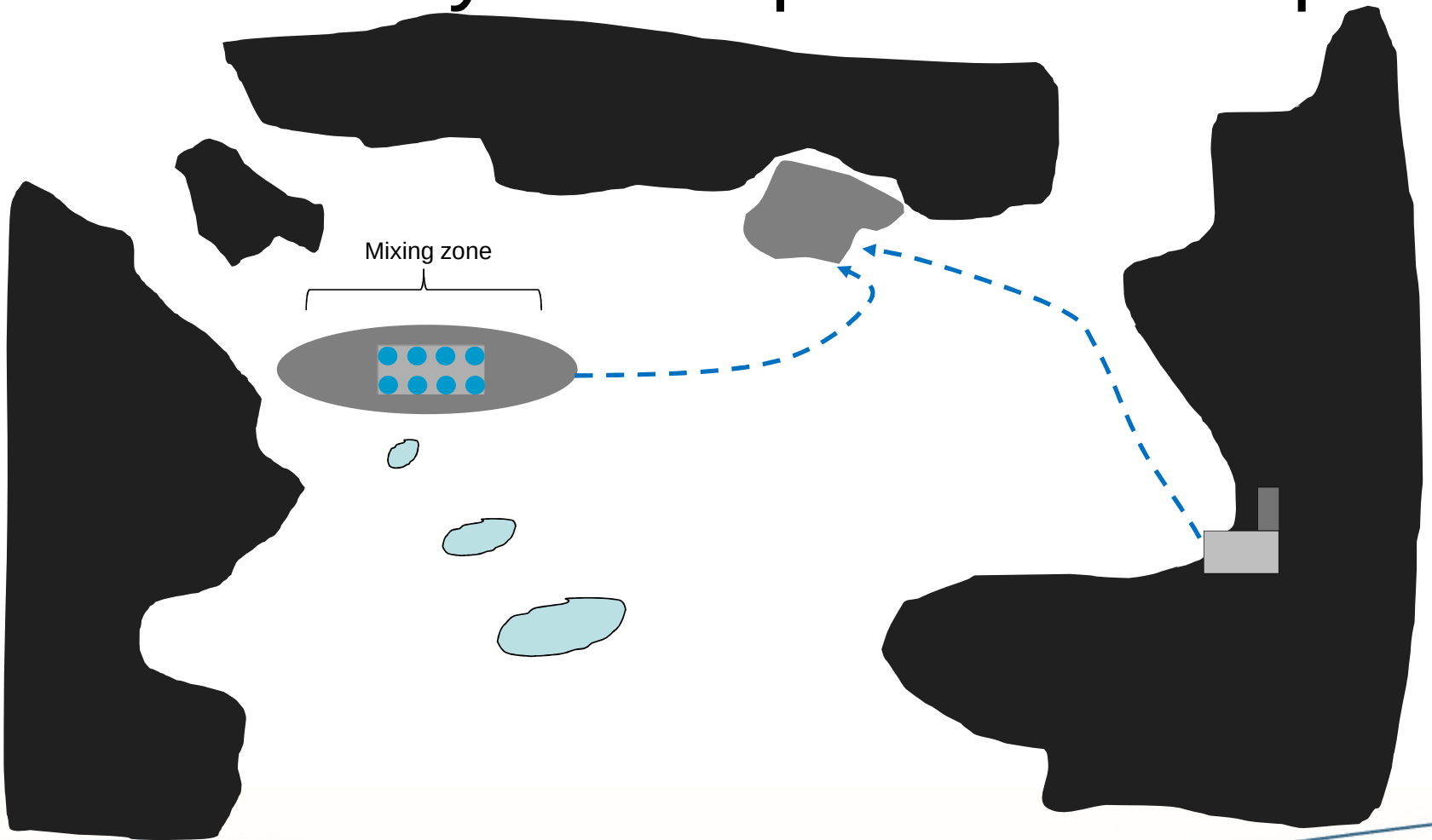
Applies to Seabed Ecology & In Feed Chemicals

Overlapping Areas

Key Concept – Mixing Zone - Aquaculture

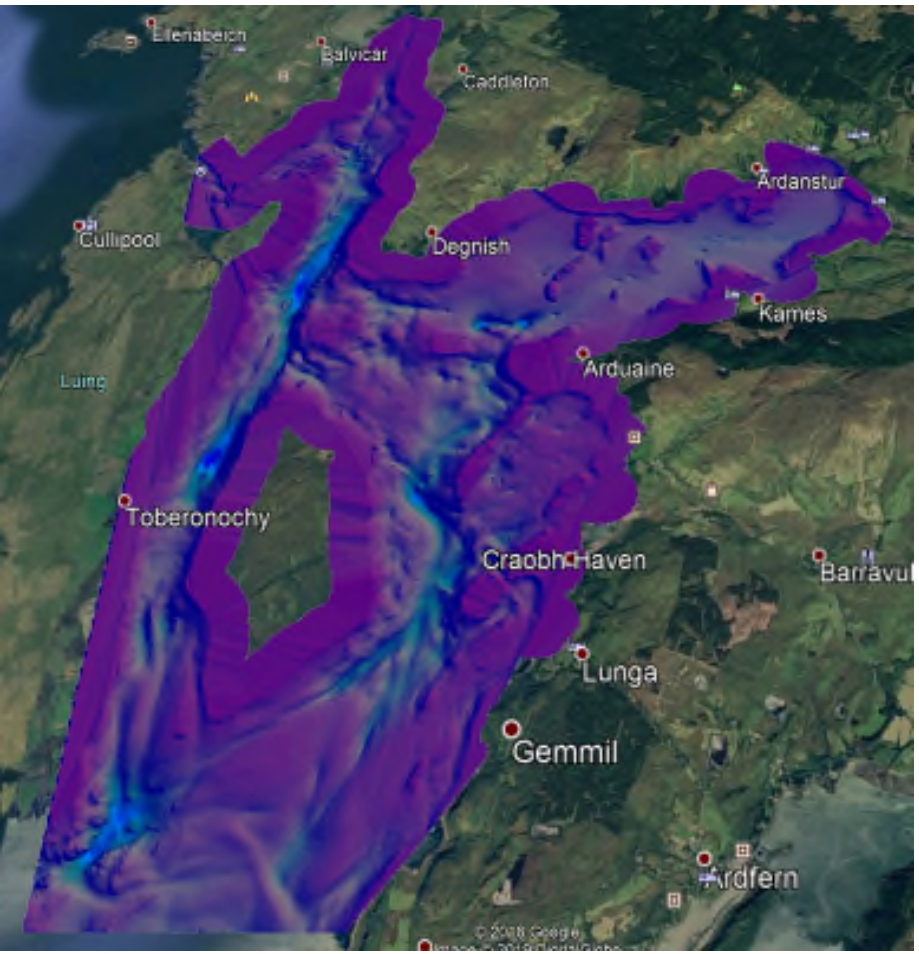


Key Concept – Wider Impacts

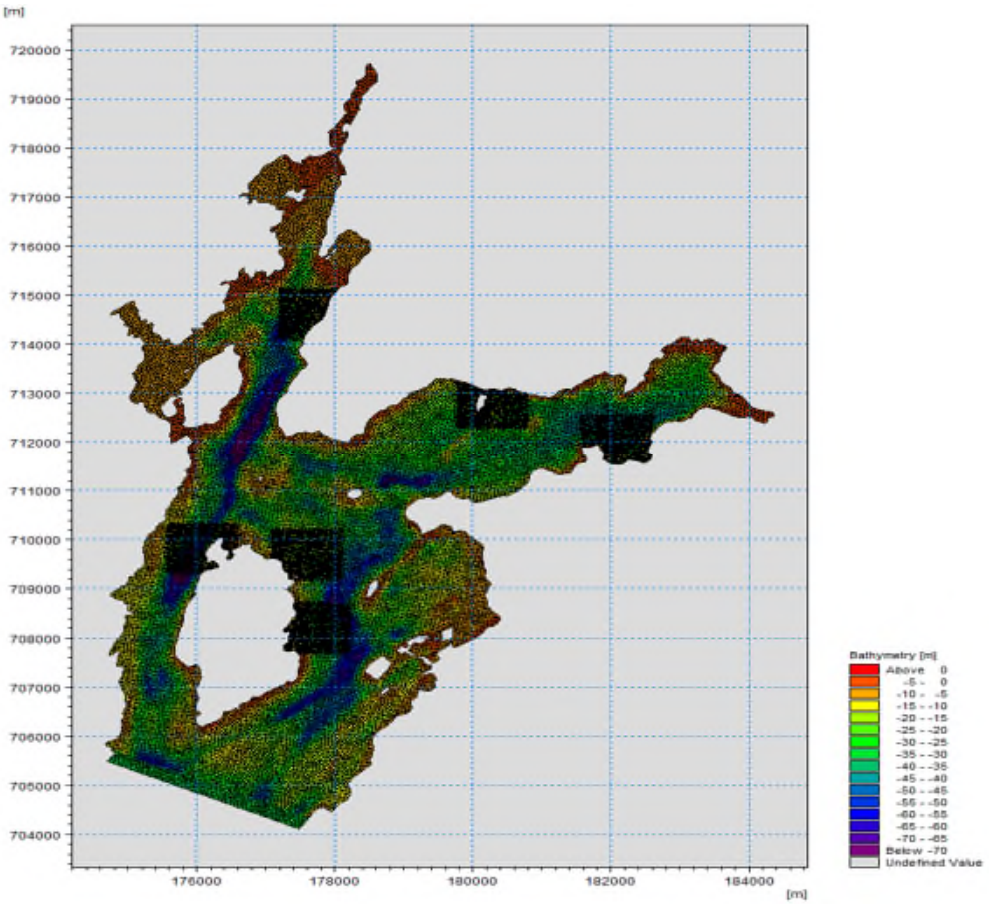


Marine Modelling

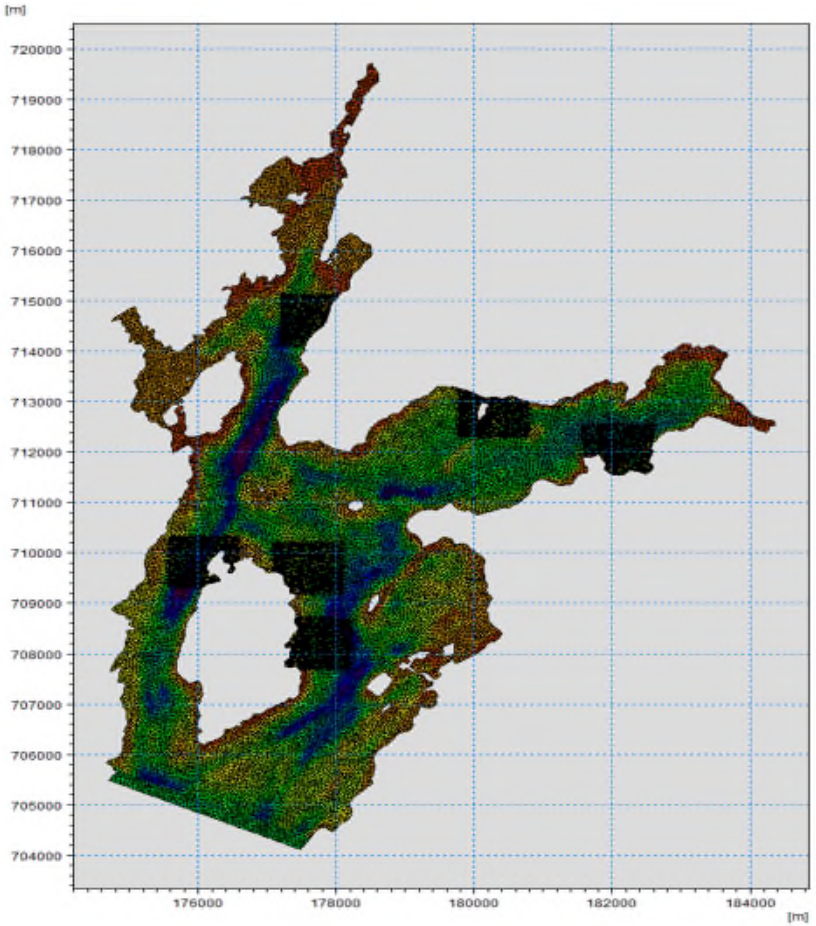
Key Concept – Marine Modelling



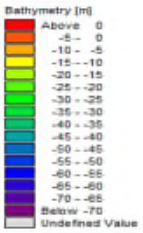
Create Mesh

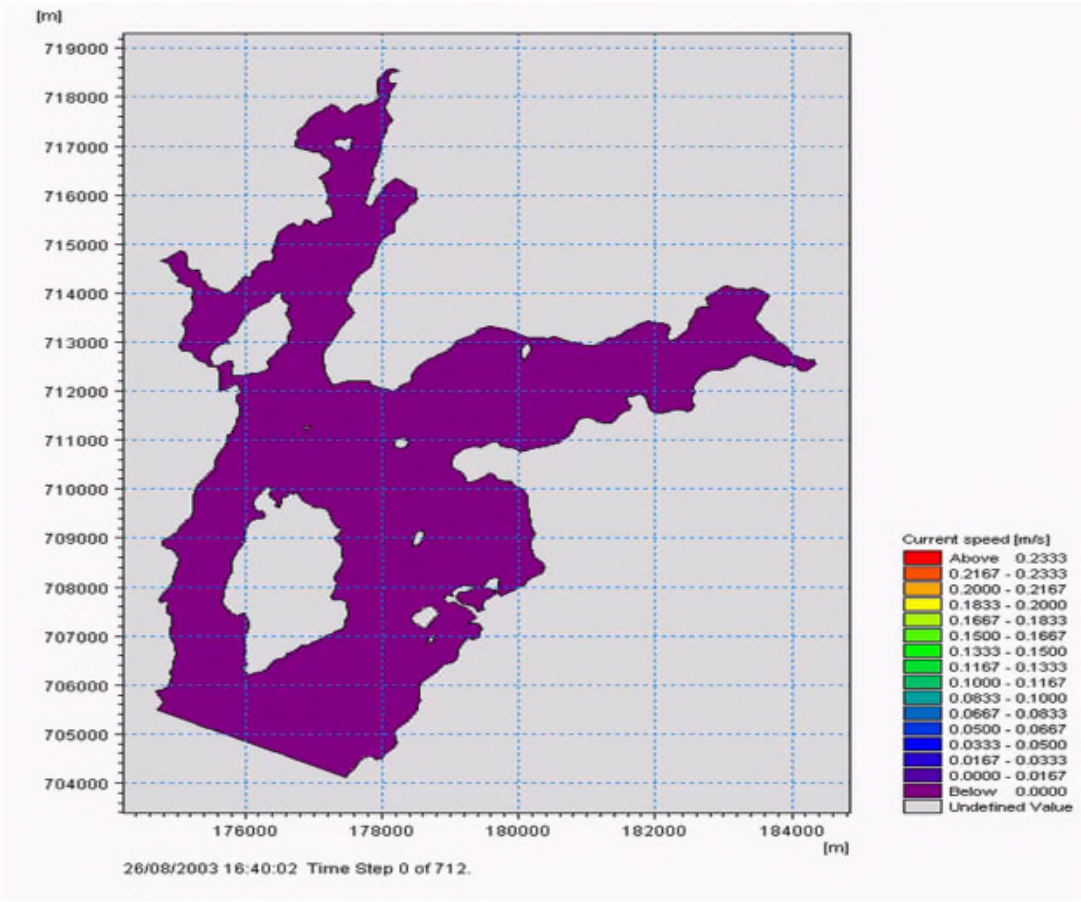


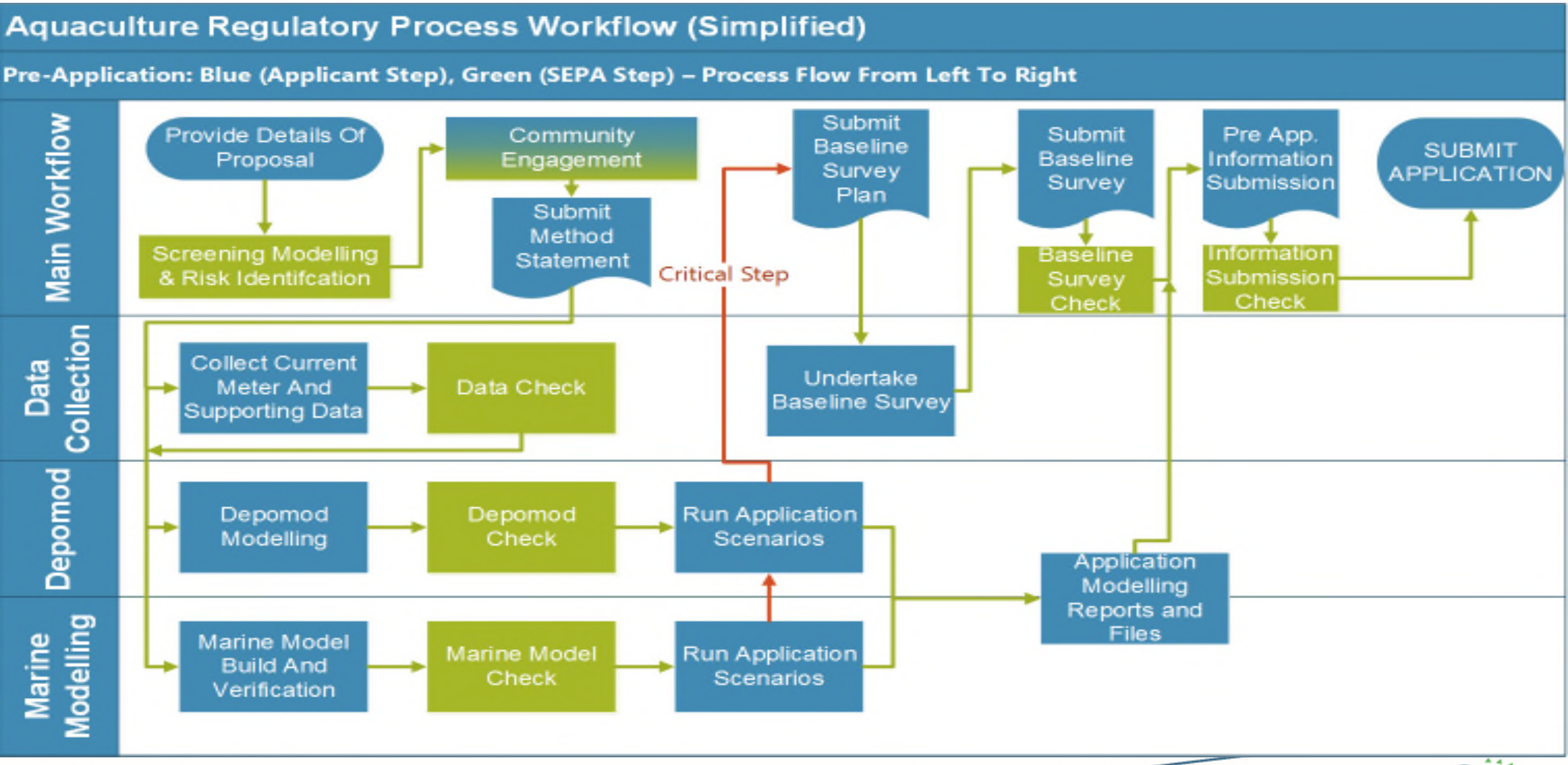
Key Concept – Marine Modelling



Run Model






Aquaculture Regulatory Process Workflow (Simplified)
Pre-Application: Blue (Applicant Step), Green (SEPA Step) – Process Flow From Left To Right
Main Workflow
Data Collection
Depomod
Marine Modelling
Provide Details Of Proposal
Community Engagement
Submit Baseline Survey Plan
Submit Baseline Survey
Pre App. Information Submission
SUBMIT APPLICATION
Screening Modelling & Risk Identifcation
Submit Method Statement
Critical Step
Baseline Survey Check
Information Submission Check
Collect Current Meter And Supporting Data
Data Check
Undertake Baseline Survey
Depomod Modelling
Depomod Check
Run Application Scenarios
Application Modelling Reports and Files
Marine Model Build And Verification
Marine Model Check
Run Application Scenarios

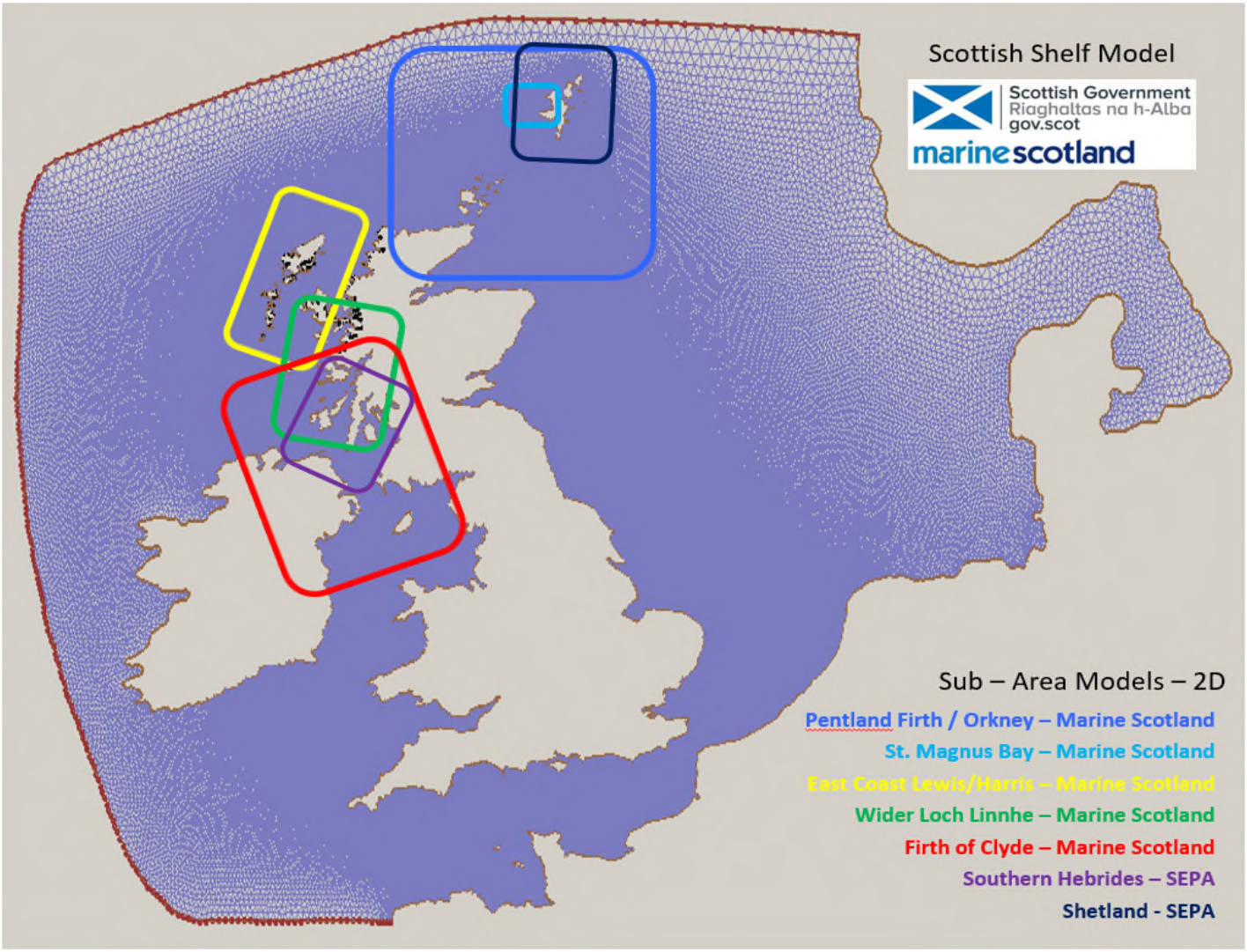
Proposed Modelling Workflow: What's New (1)

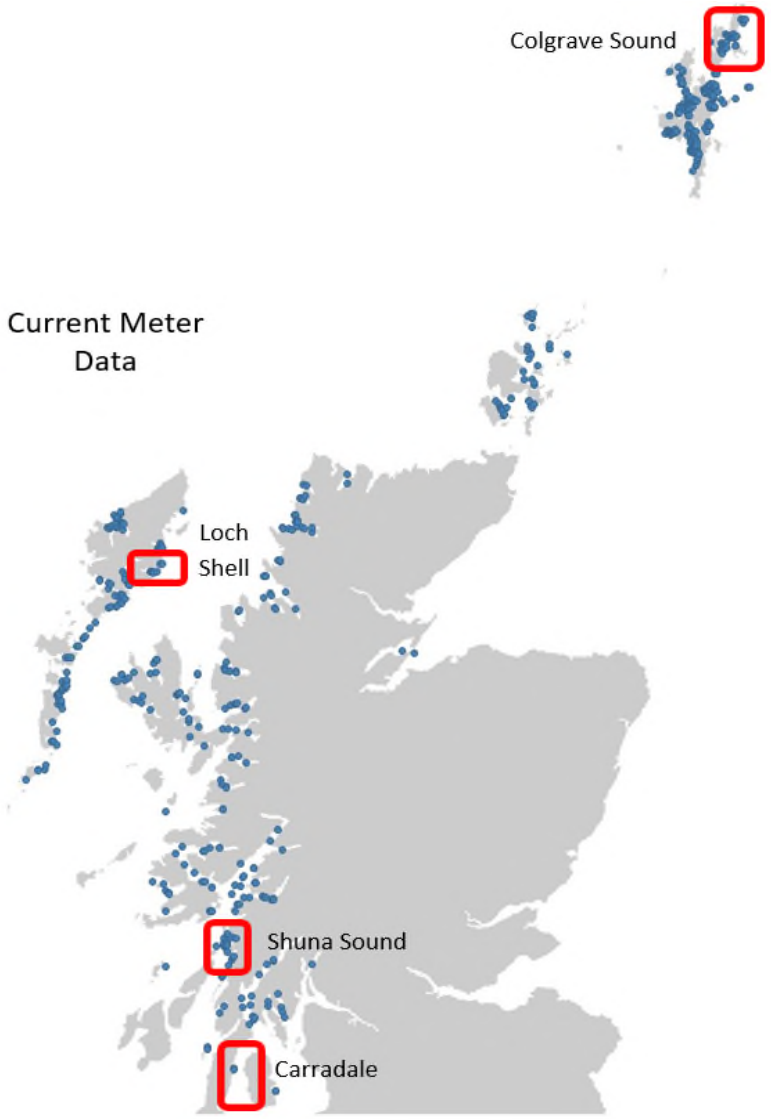
Present Approach	New Approach
Minimal Pre-Application Discussion.	Structured Pre-Application Discussion.
No Initial Screening of Impacts.	Initial Screening Modelling To Inform Risk Discussion.
No Agreed Method For Addressing Risks – Rely On Standard Method For All.	Agreed "Method Statement" To Address Risks – Flexible and Risk Proportionate.
15 Days Of Current Meter Data – Not Always Checked At Pre-App.	90 Days of Current Meter Data Checked At Pre-App - Required.

Proposed Modelling Workflow: What's New (2)

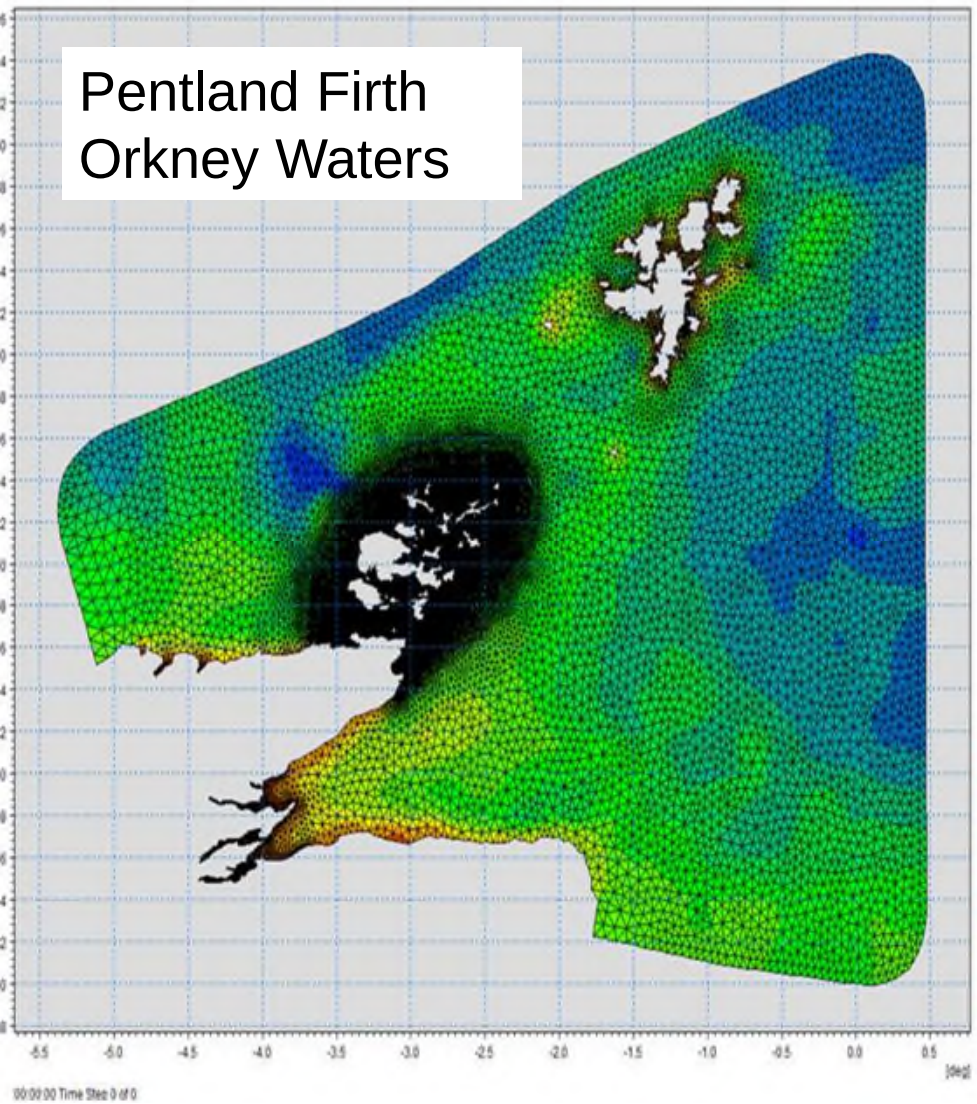
Present Approach	New Approach
Local Impact Modelling With Old Model.	Local Impact Modelling With New Model.
Simple Assessment Of Spatial/Cumulative Impact And Interactions.	Marine Modelling To Inform Spatial/Cumulative Impact And Interactions.
Bath Treatment Modelling With Old Simplified Tools.	Bath Treatment Modelling with Marine Model.
Some Modelling/Data Issues Often Identified At Application Stage = Potential Delays.	Modelling/Data Issues Identified At Pre-App Stage.

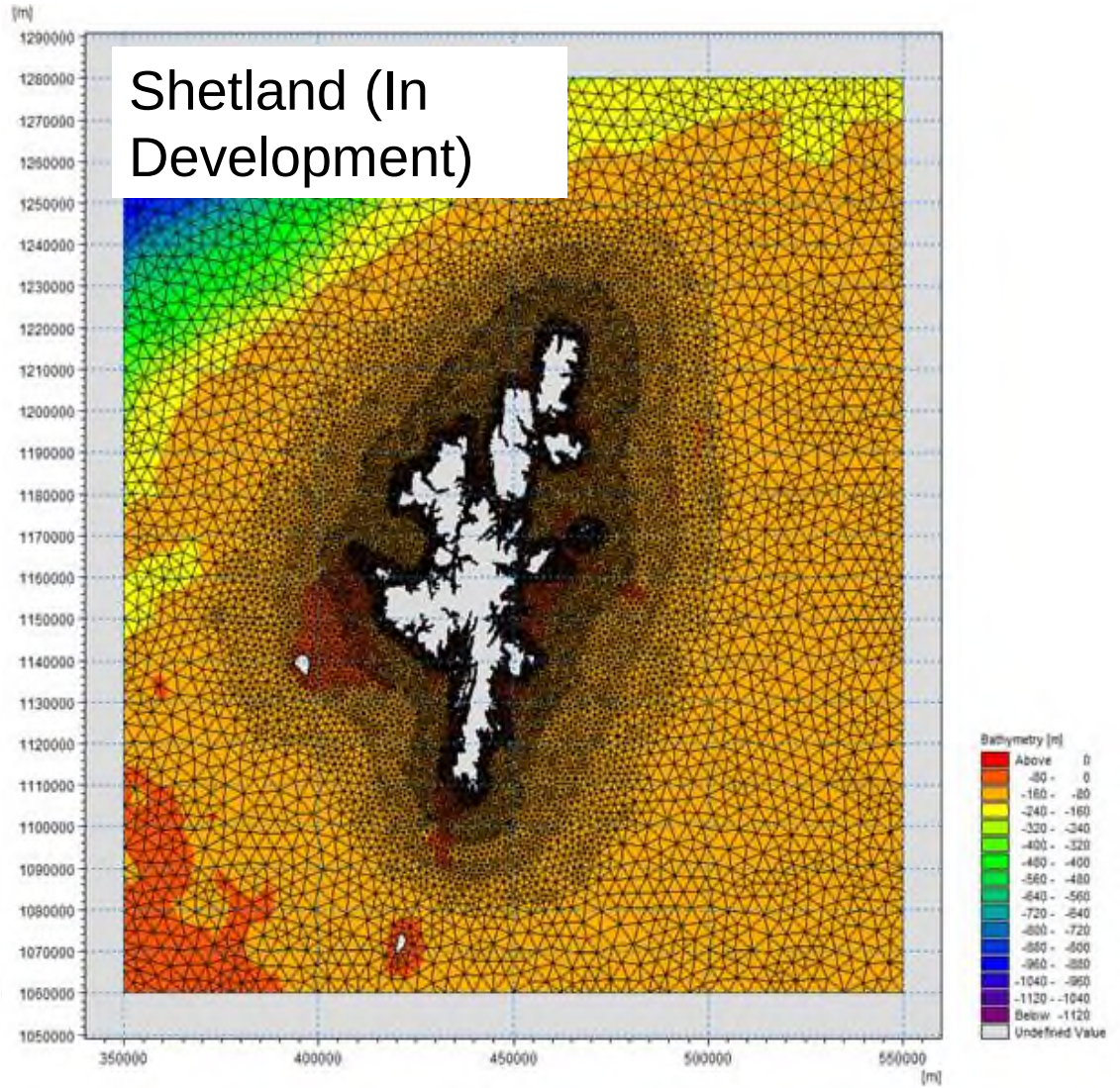
Screening Modelling – Coverage – 2D Models



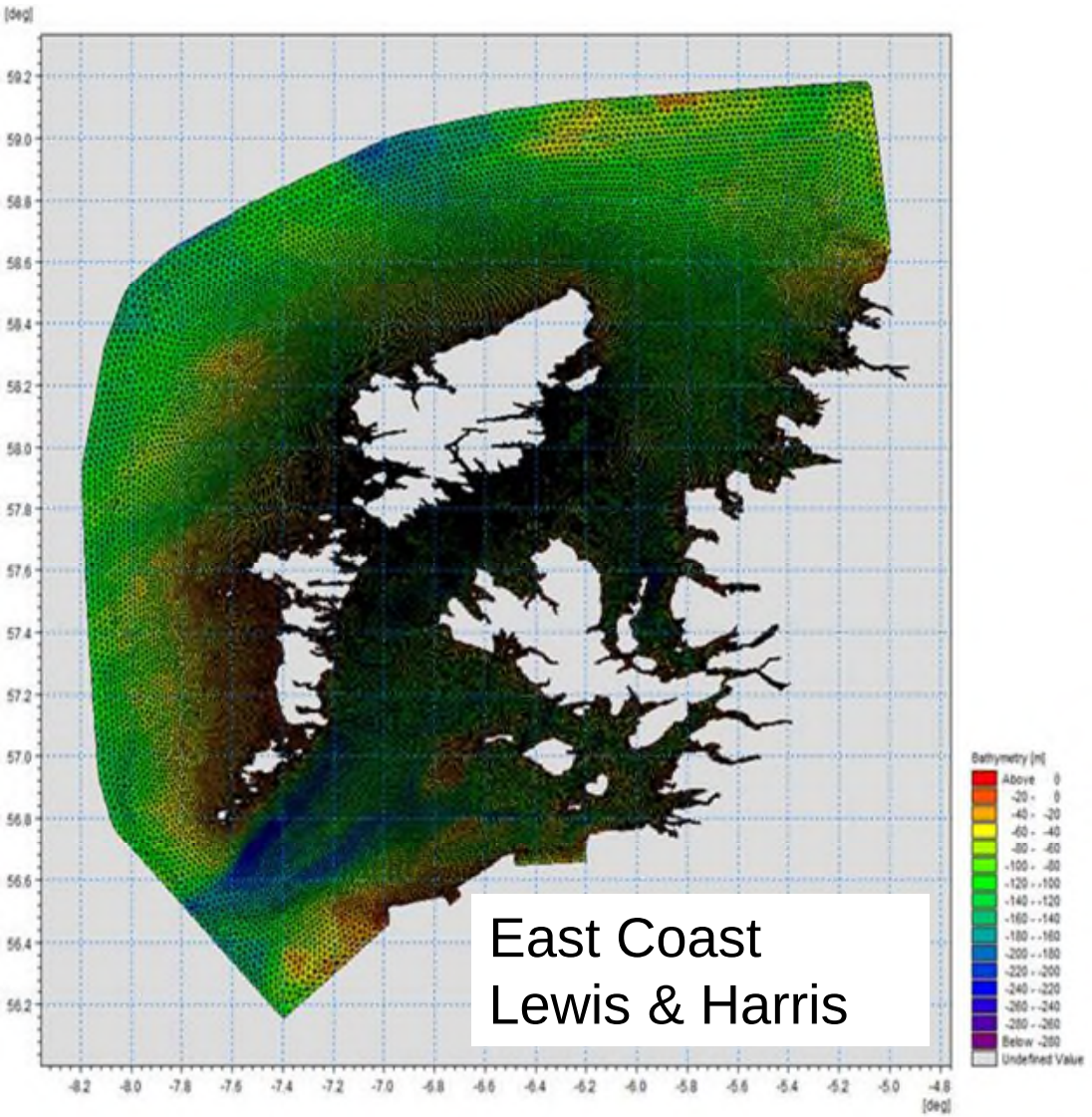


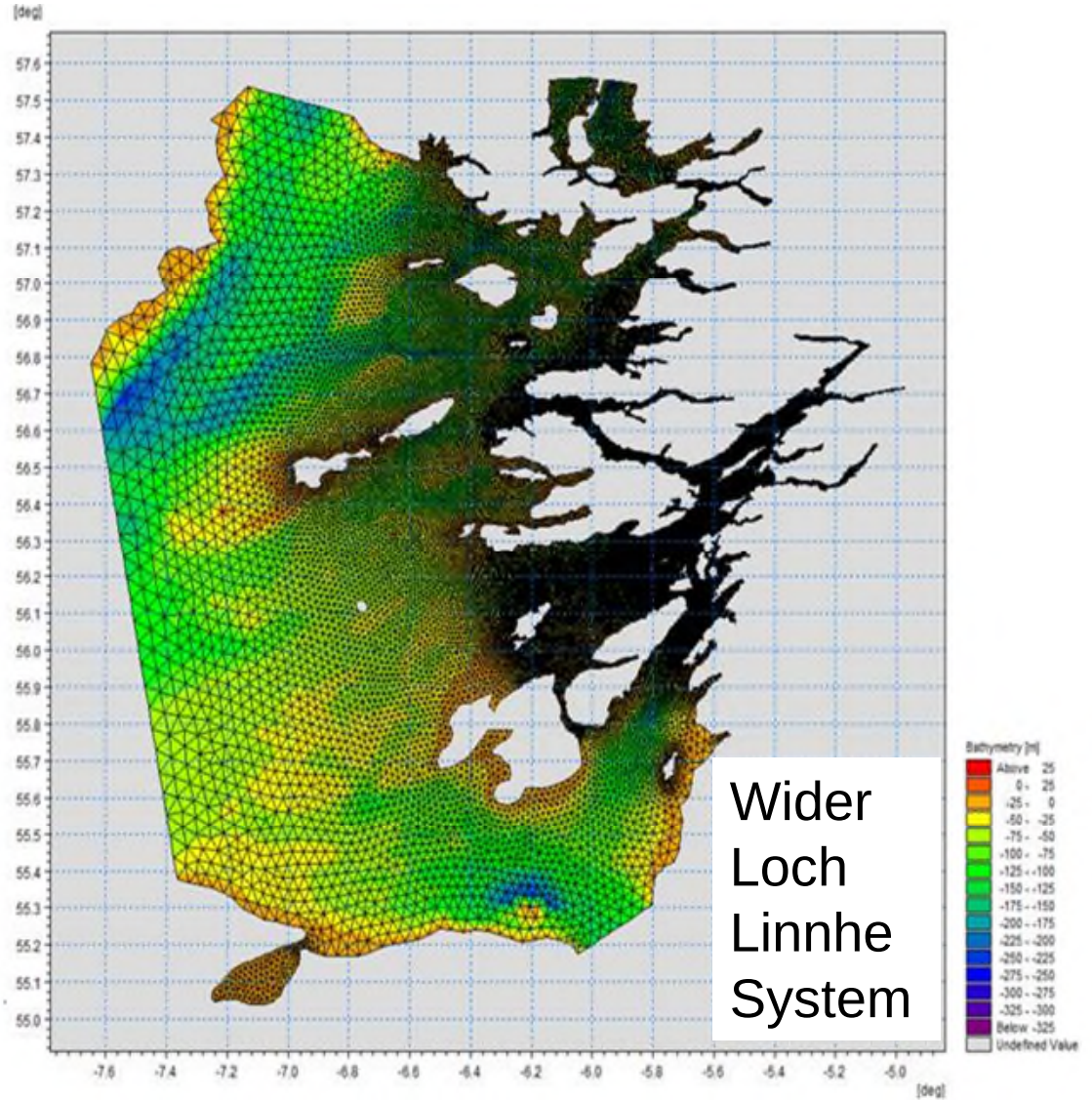
Screening Modelling – Coverage – 2D Models



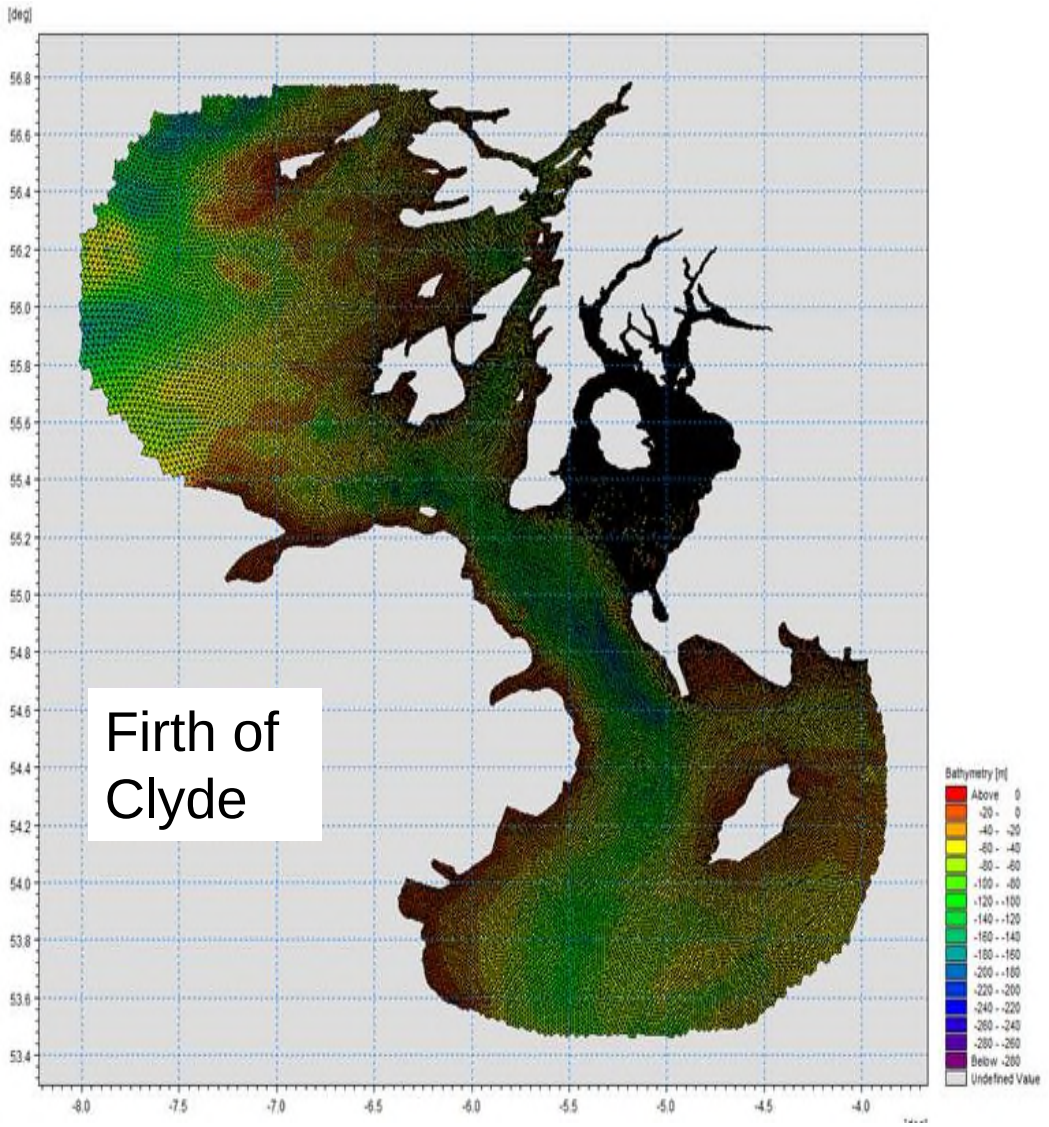


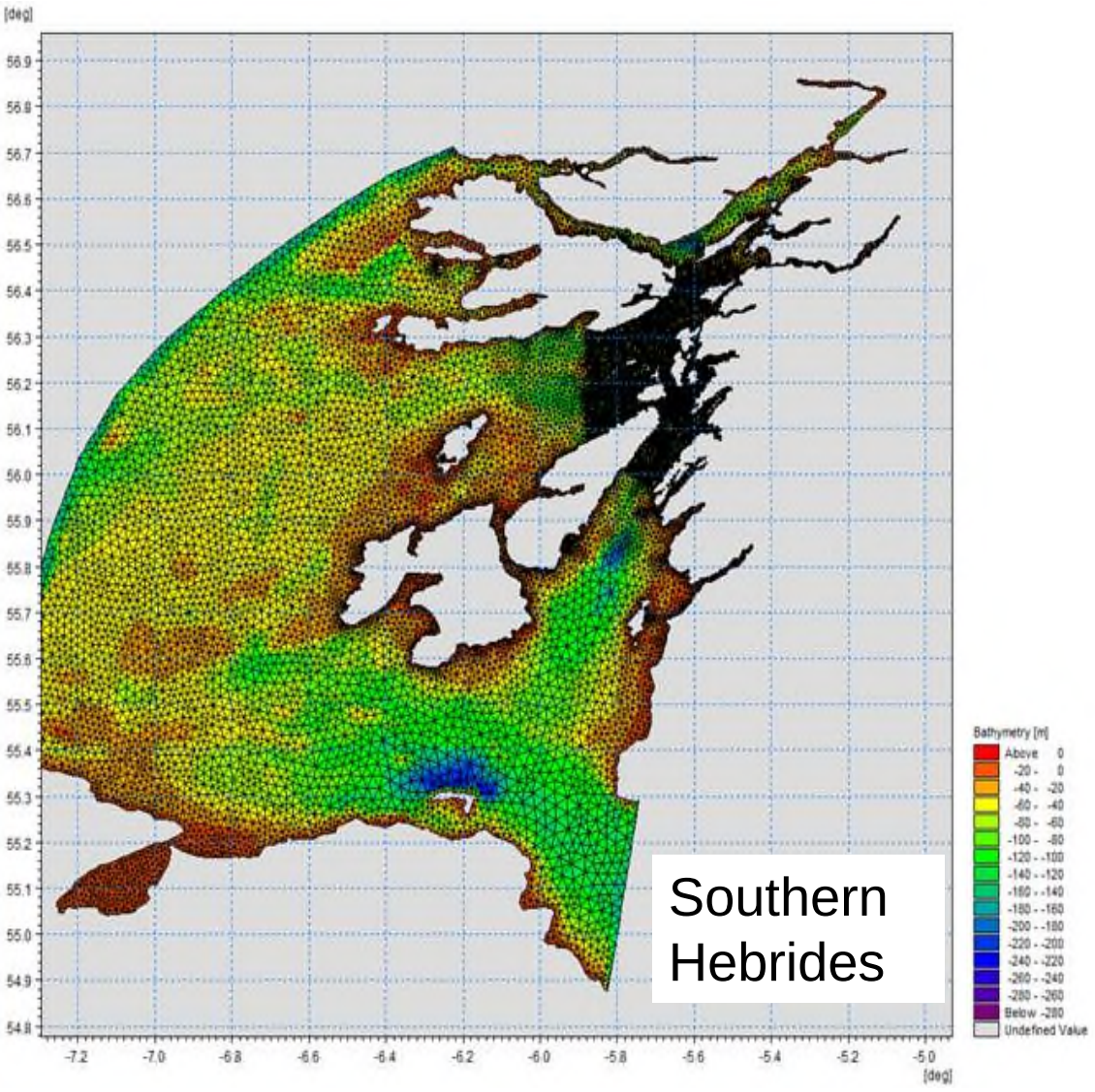
Screening Modelling – Coverage – 2D Models



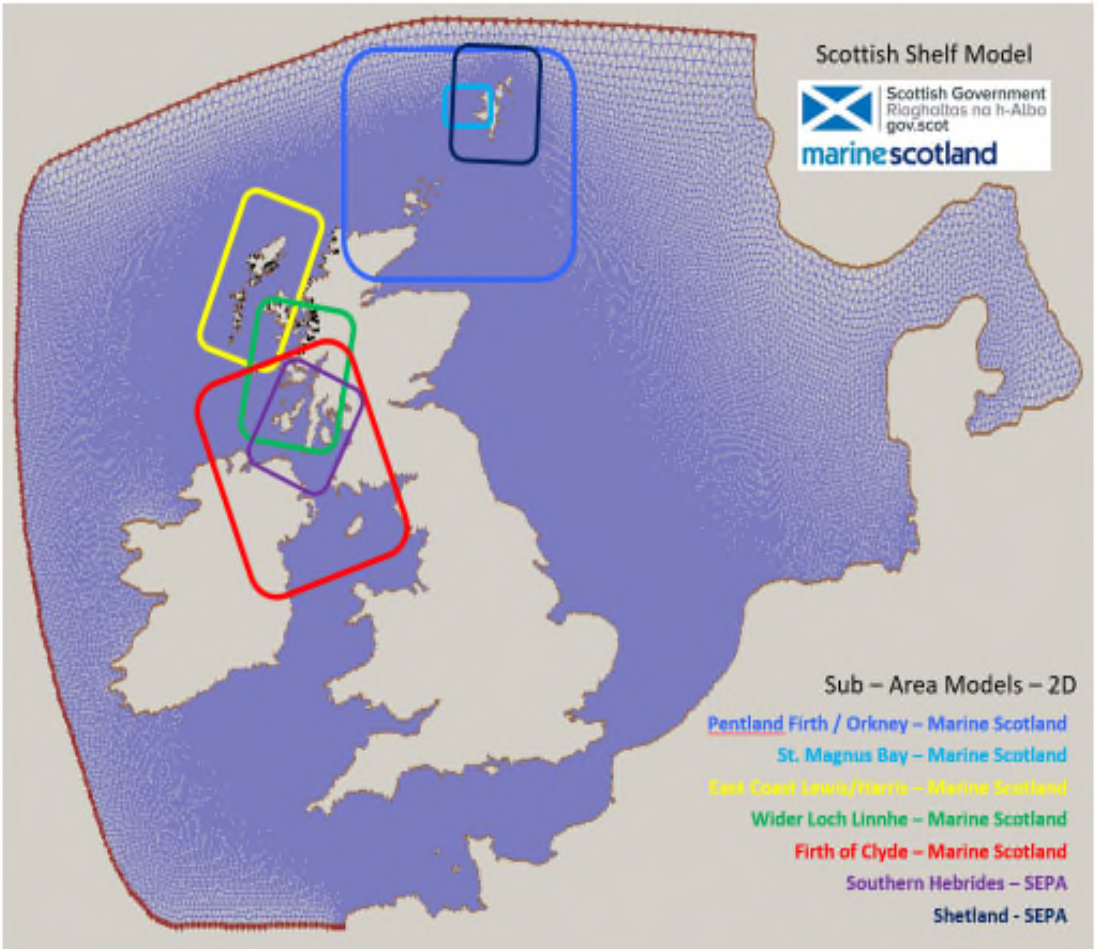


Screening Modelling – Coverage – 2D Models



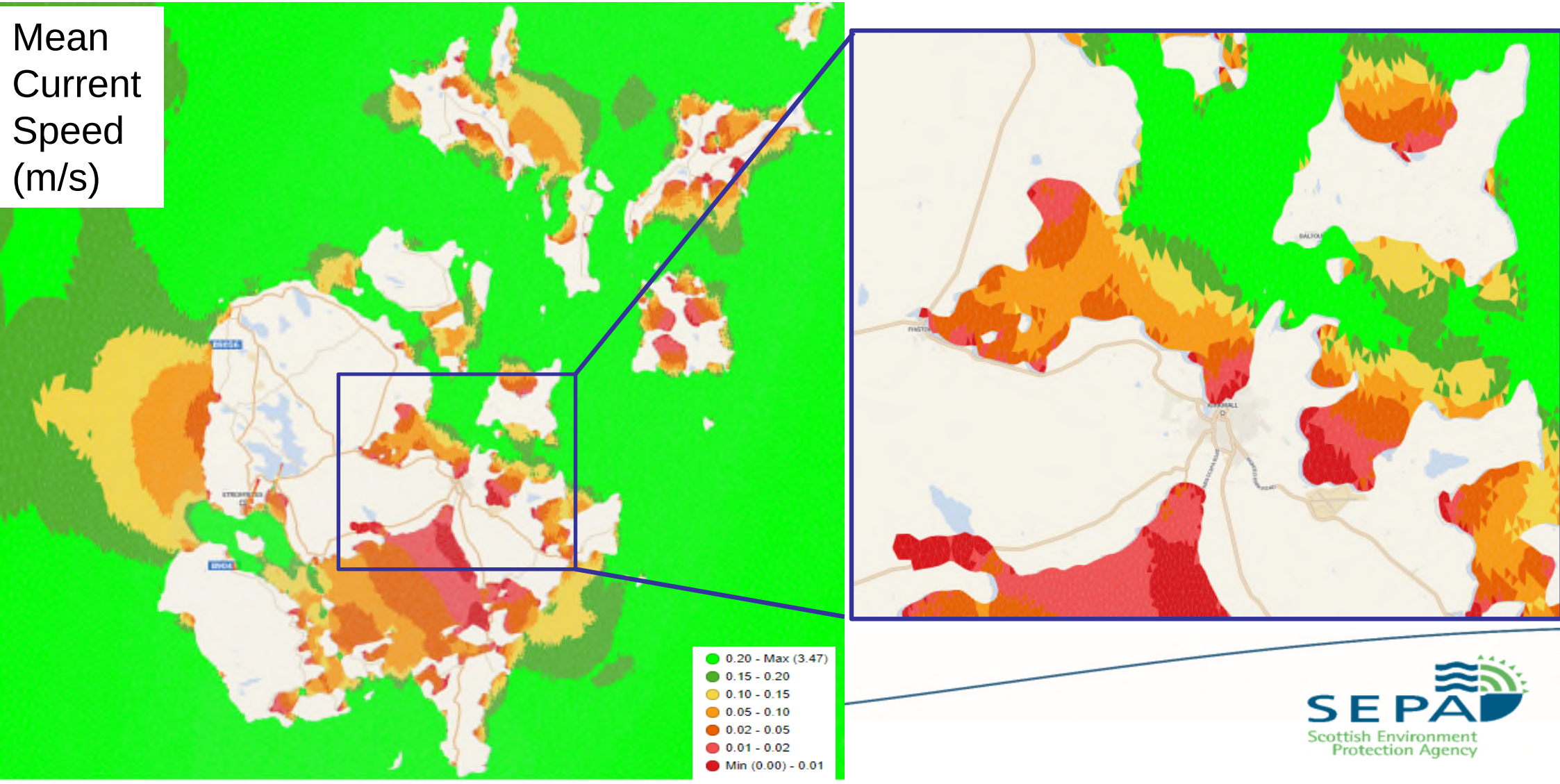


Screening Modelling – Method – 2D Models



- Indicative One Month Run Using Average:
  - Tide
  - Wind
  - River Flow
- Particle Modelling (Sediment, In-Feeds).
- Dissolved Modelling (Bath, Nutrients).
- Can Include Inputs From Multiple Sources.

Screening Modelling – Output – Current Speed



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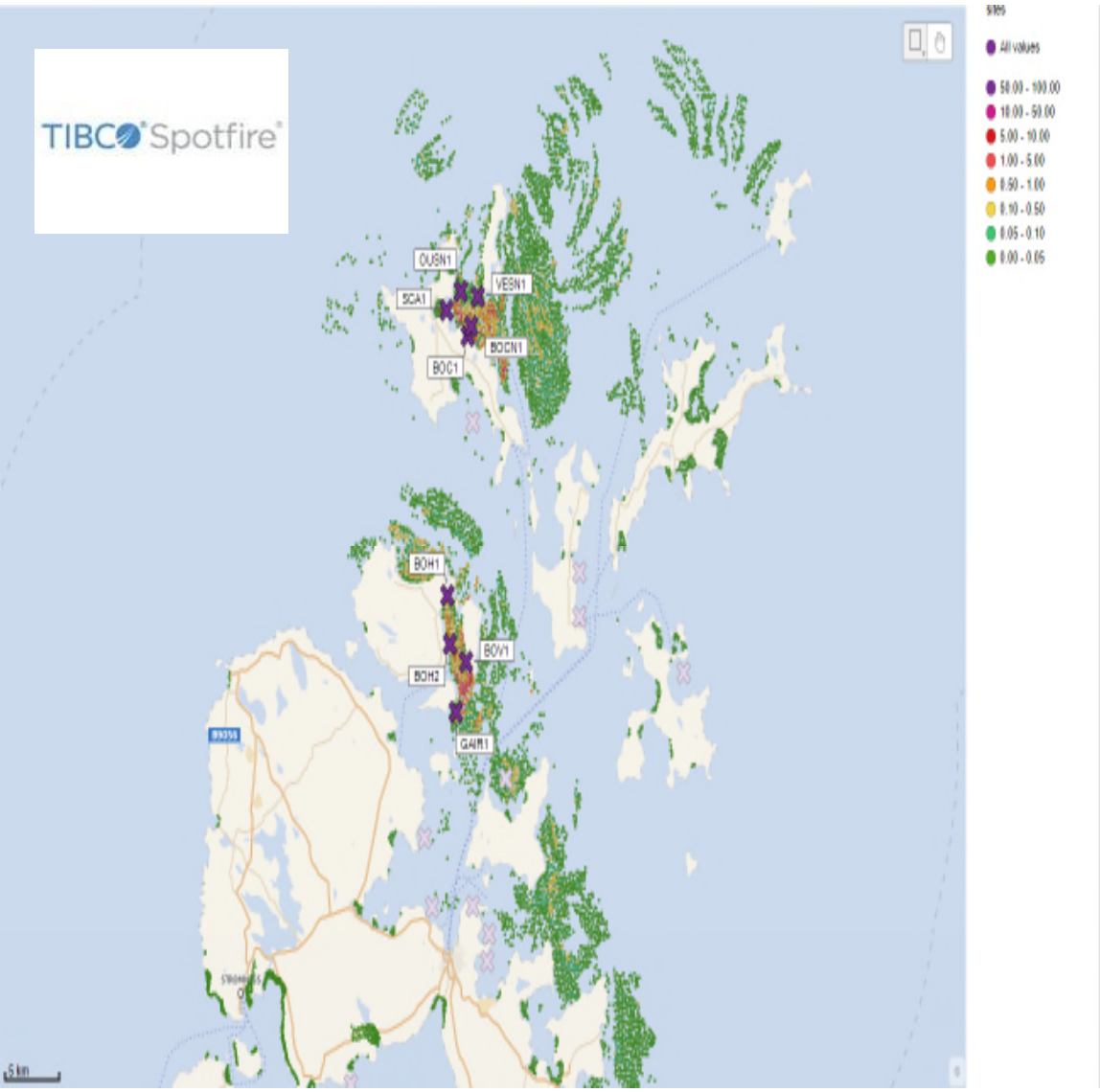
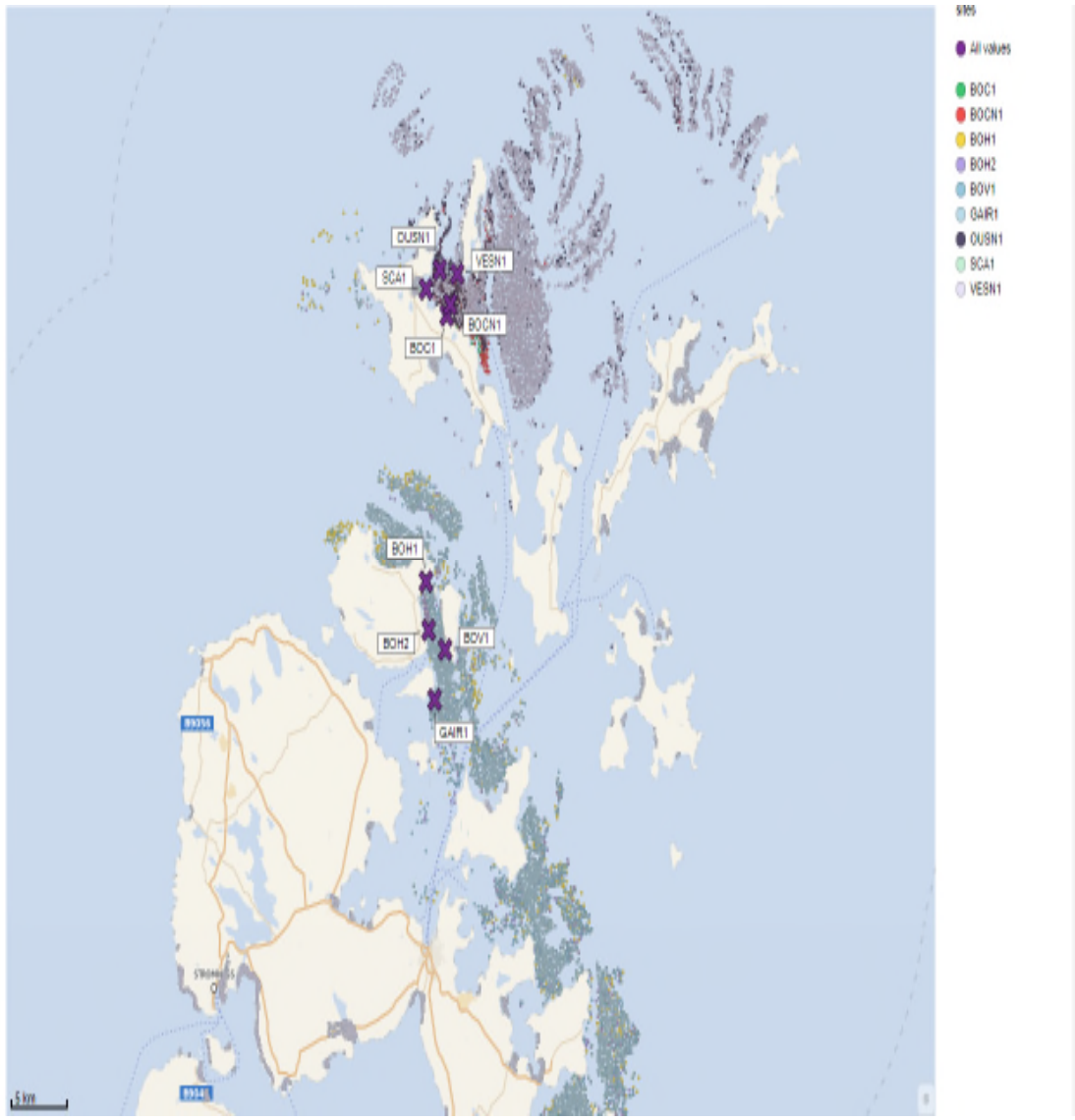
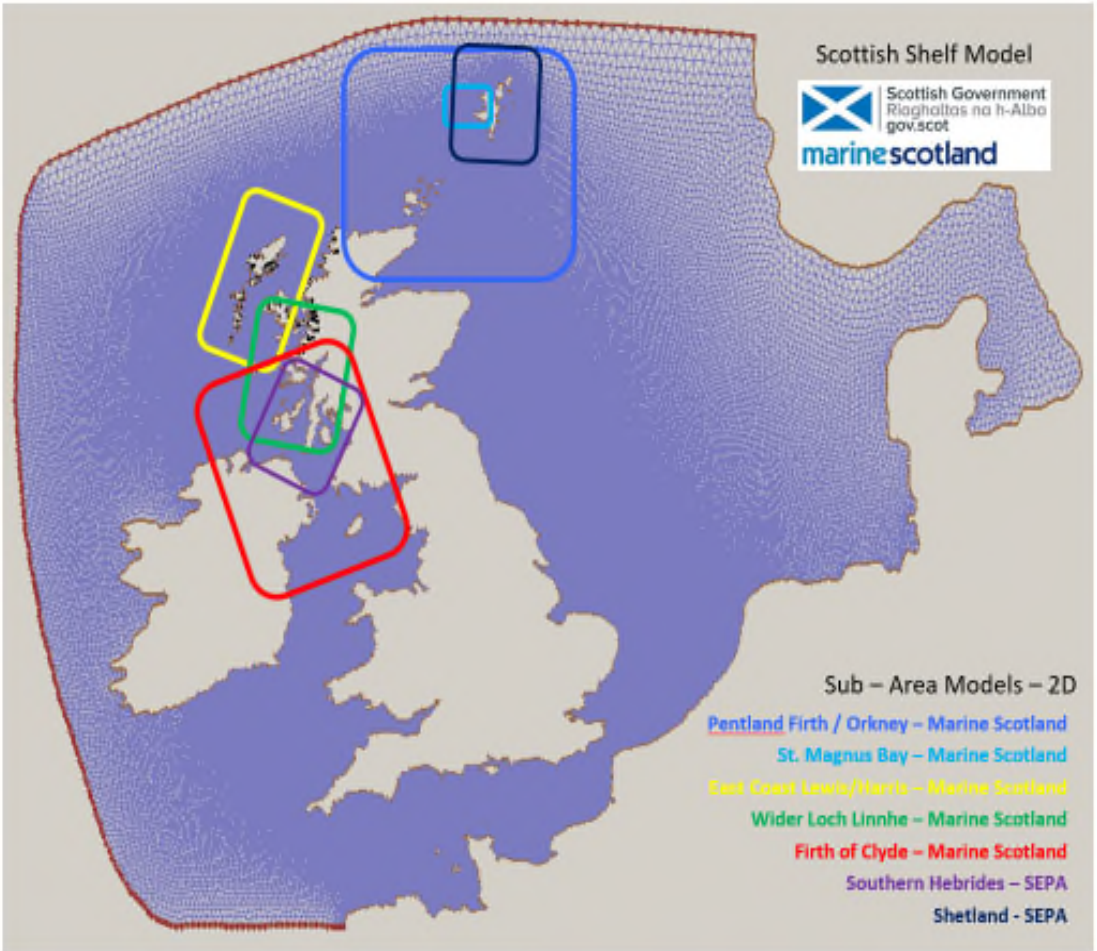
Scottish Environment Protection Agency

Screening Modelling – Output – Particle Modelling





Screening Modelling – Advantages



- Consistent Modelling Method.
- Informs Risk Discussion At An Early Stage.
- Visualisation Of Potential Impacts Helps with Discussions.
- Assists with Marine Modelling Development.
- Method Can Be Improved and Refined Over Time.

Local scale (“mixing zone”) modelling - NewDepomod

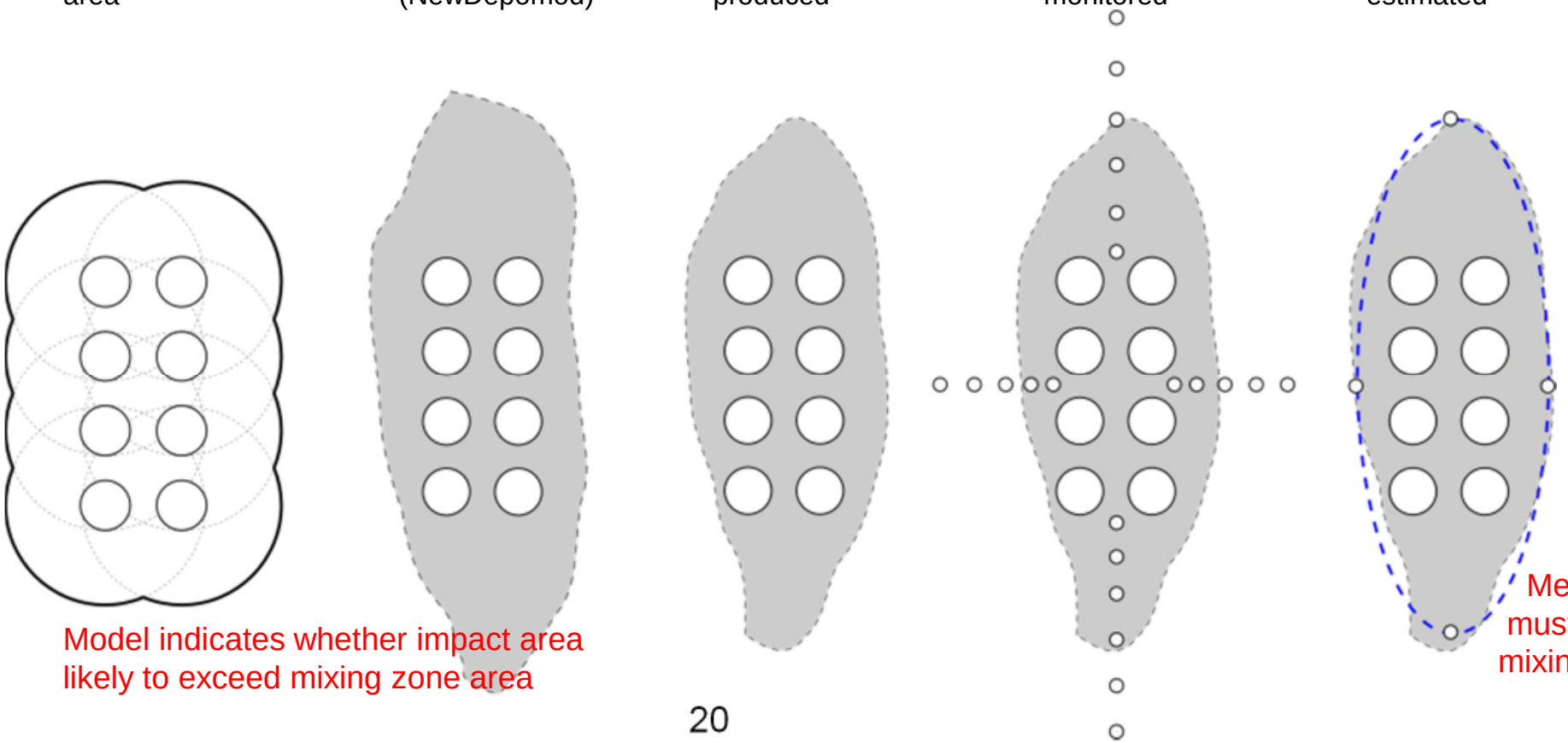
Calculate mixing zone area

Predicted impact area (NewDepomod)

Actual impact produced

Actual impact monitored

Actual impact area estimated

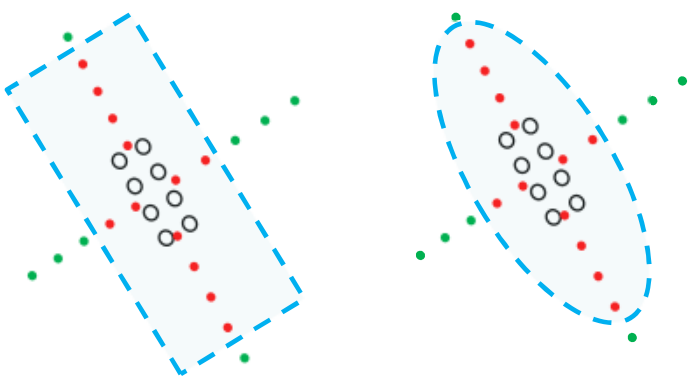


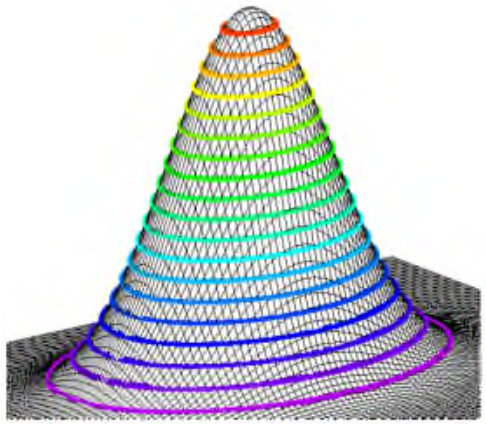
Model indicates whether impact area likely to exceed mixing zone area

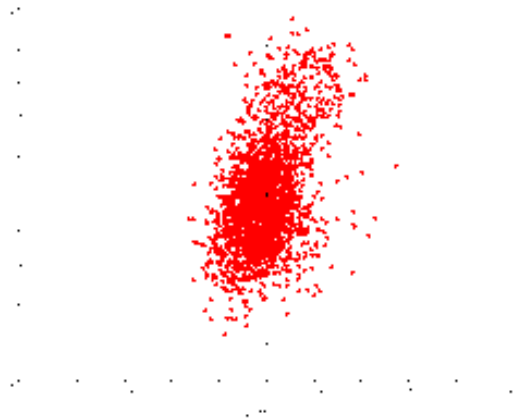
Measured area must not exceed mixing zone area

Why ellipses?

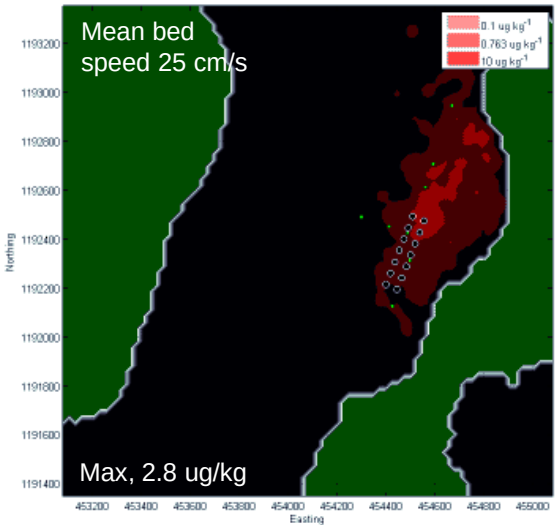
- Need to produce area estimate from limited data – simplifying assumptions required
- Dispersive processes acting equally in all directions expected to produce circular impact
- In cases where bi-directional asymmetries occur this generalises to an ellipse
- Tidal currents described conceptually in terms of “tidal ellipses”
- Ellipse can be fitted to arbitrary numbers of sampling transects

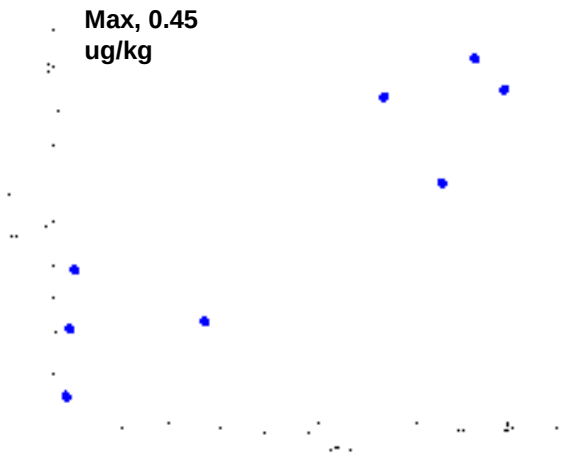


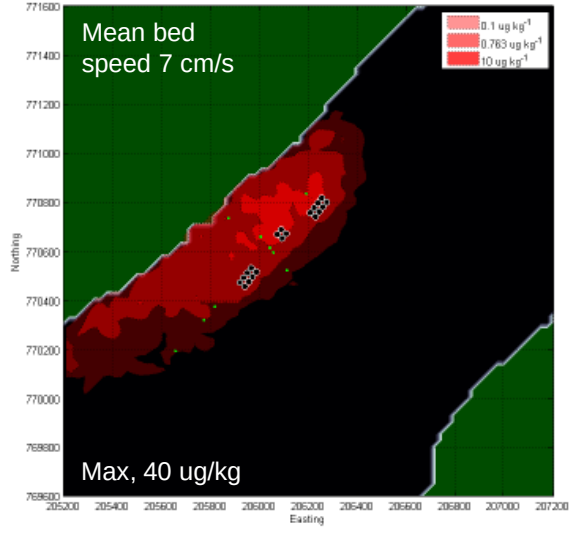


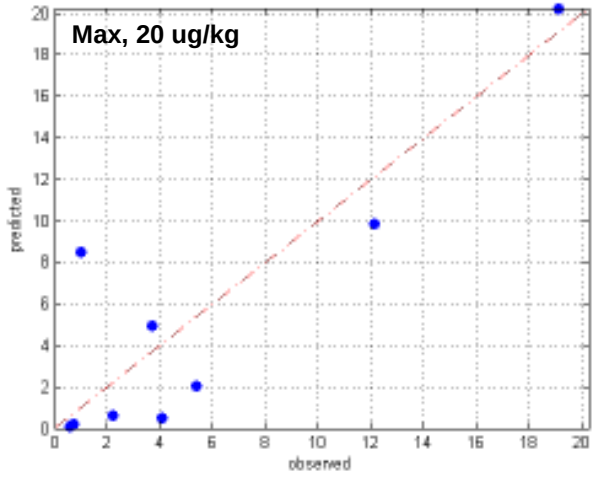


NewDepomod

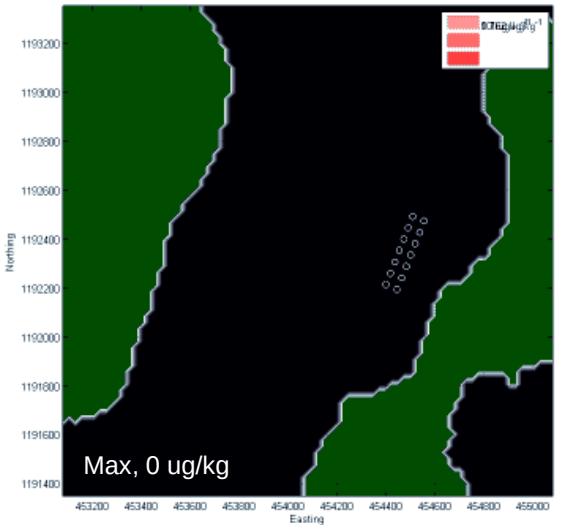


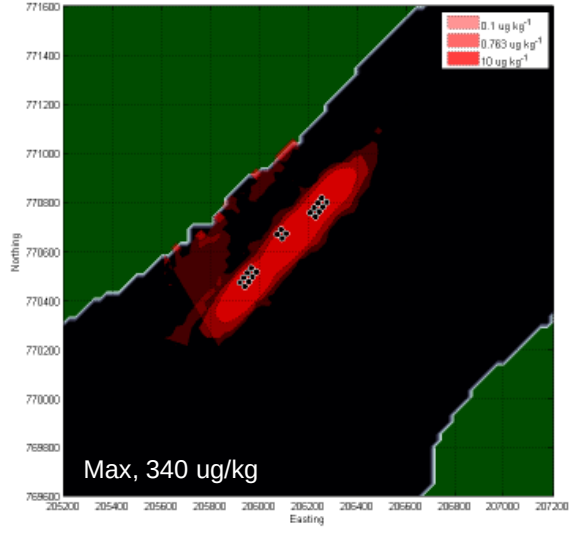


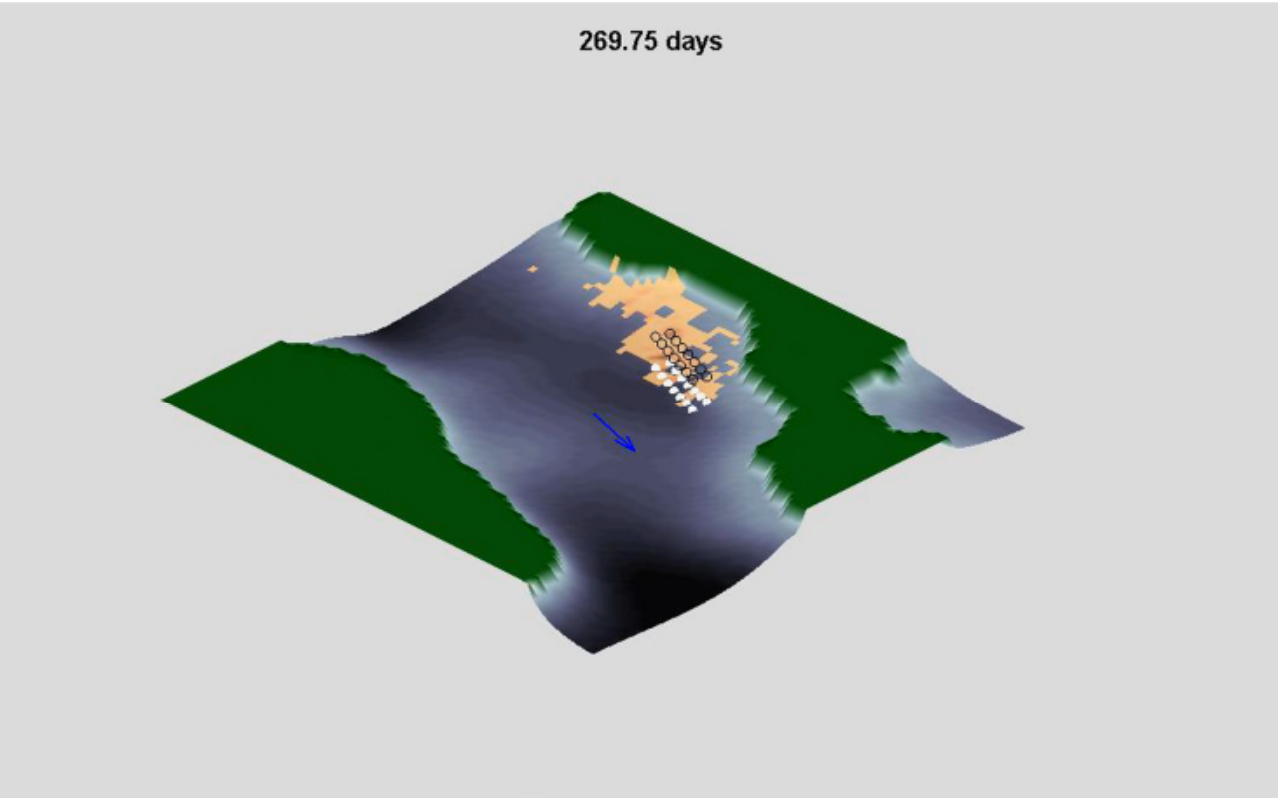




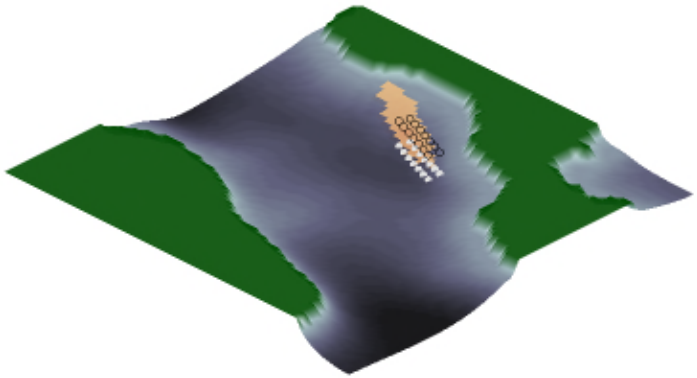
AutoDepomod



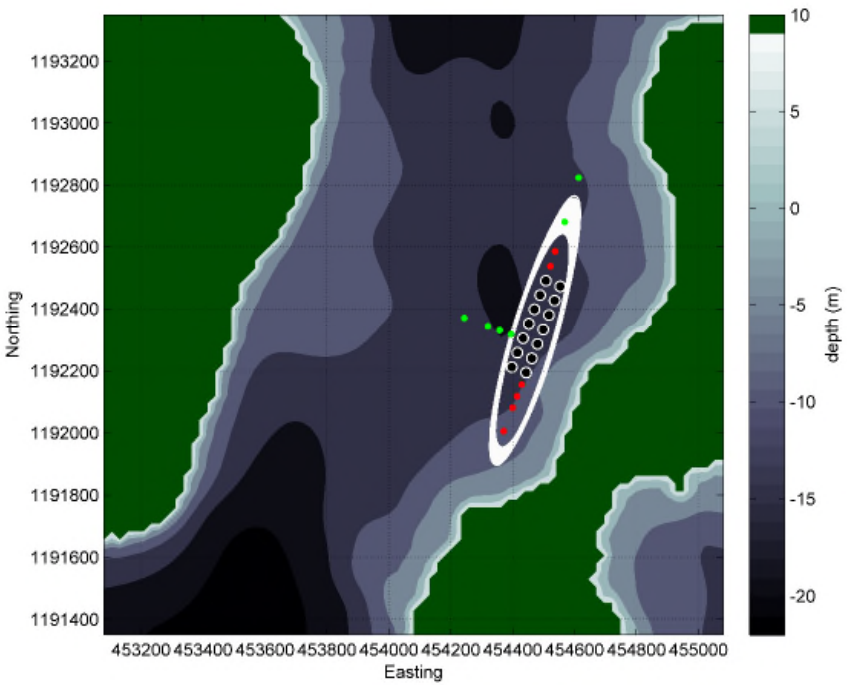




Modelled, 90,124 m²



Measured, 89,317 m²



- AutoDepomod used a <u>single snapshot in time</u> of deposition to identify ecological impacts
- This is not reliable given that deposition can vary on hourly timescales
- Most robust signal for predicting IQI impact area is based on <u>*average* deposition rates</u> through time

Local scale (“mixing zone”) modelling - NewDepomod

- Improves on AutoDepomod: predicts impacts in high-energy locations, distributes material more realistically in lower-energy areas
- Good for impact *scale*, sometimes with positional errors
- Performance can be anchored and validated with good seabed data – this should become common practice for existing sites given future monitoring requirements
- New methodological guidance issued shortly

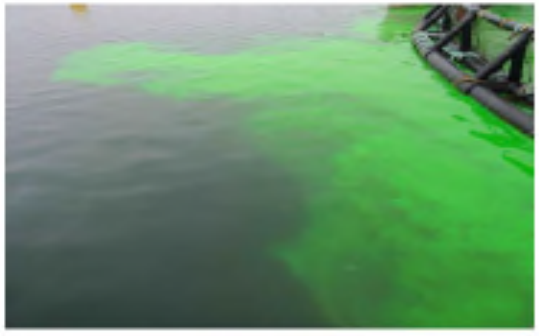
Marine Modelling/Bath Treatment Modelling





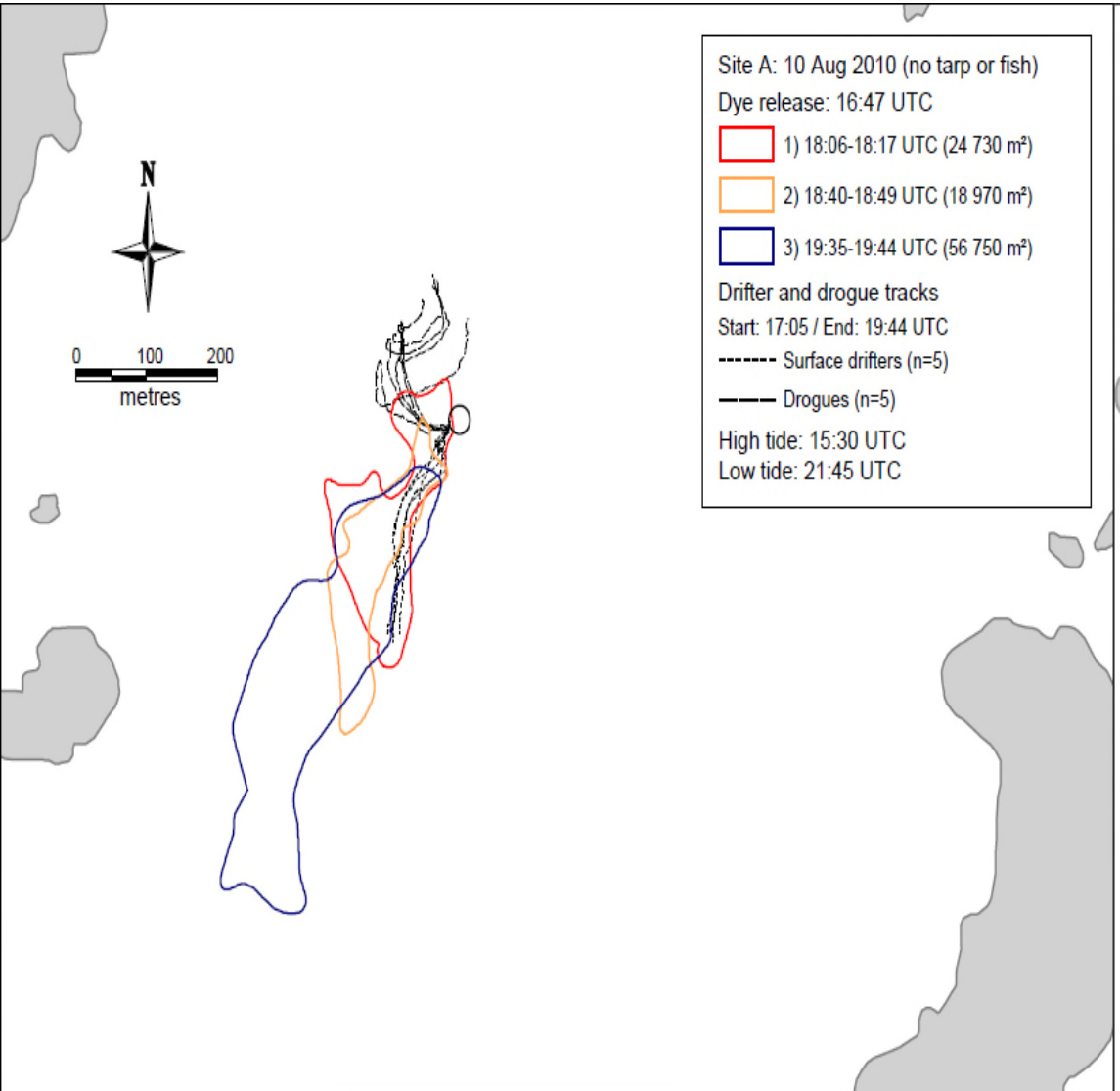


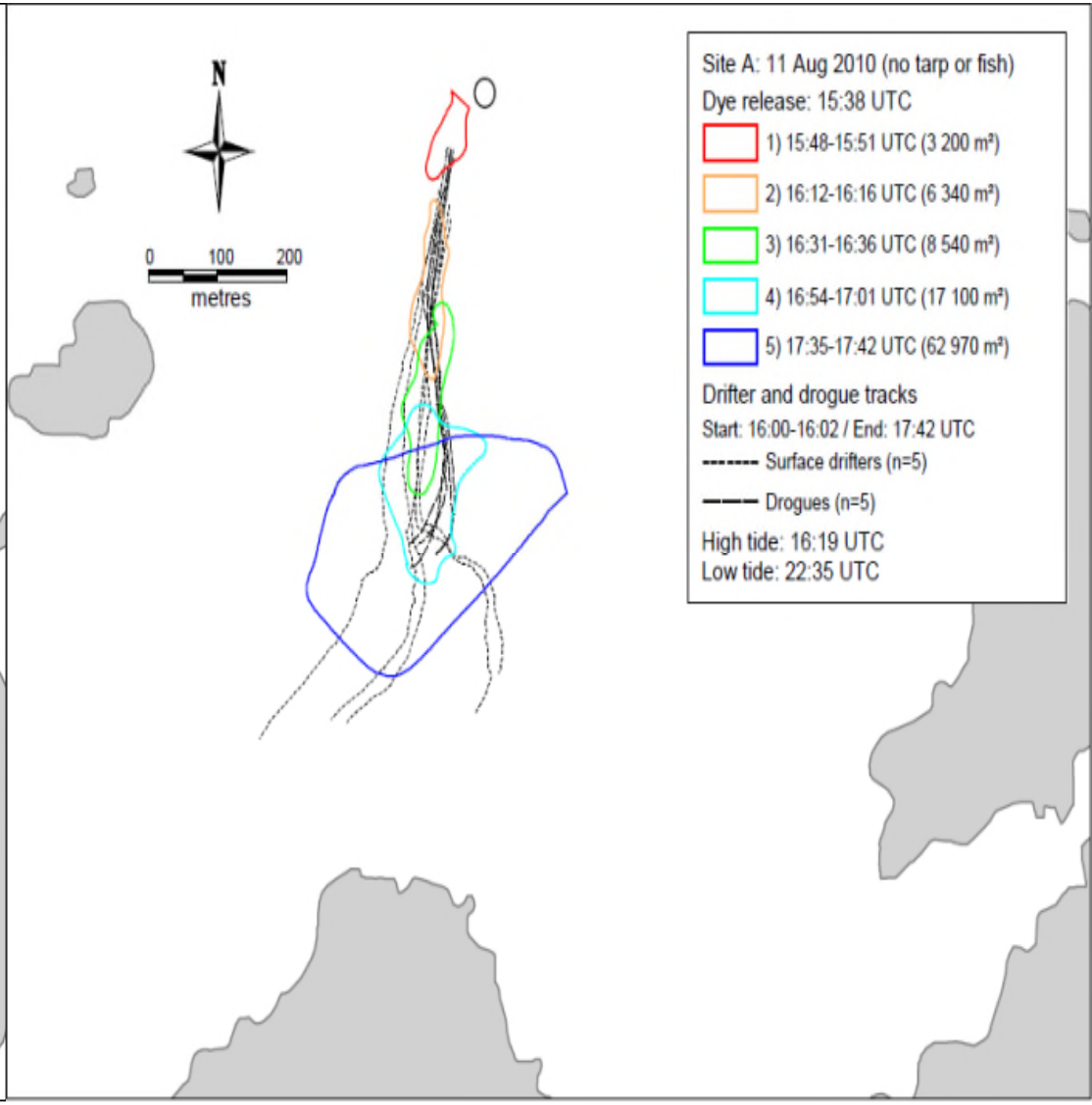


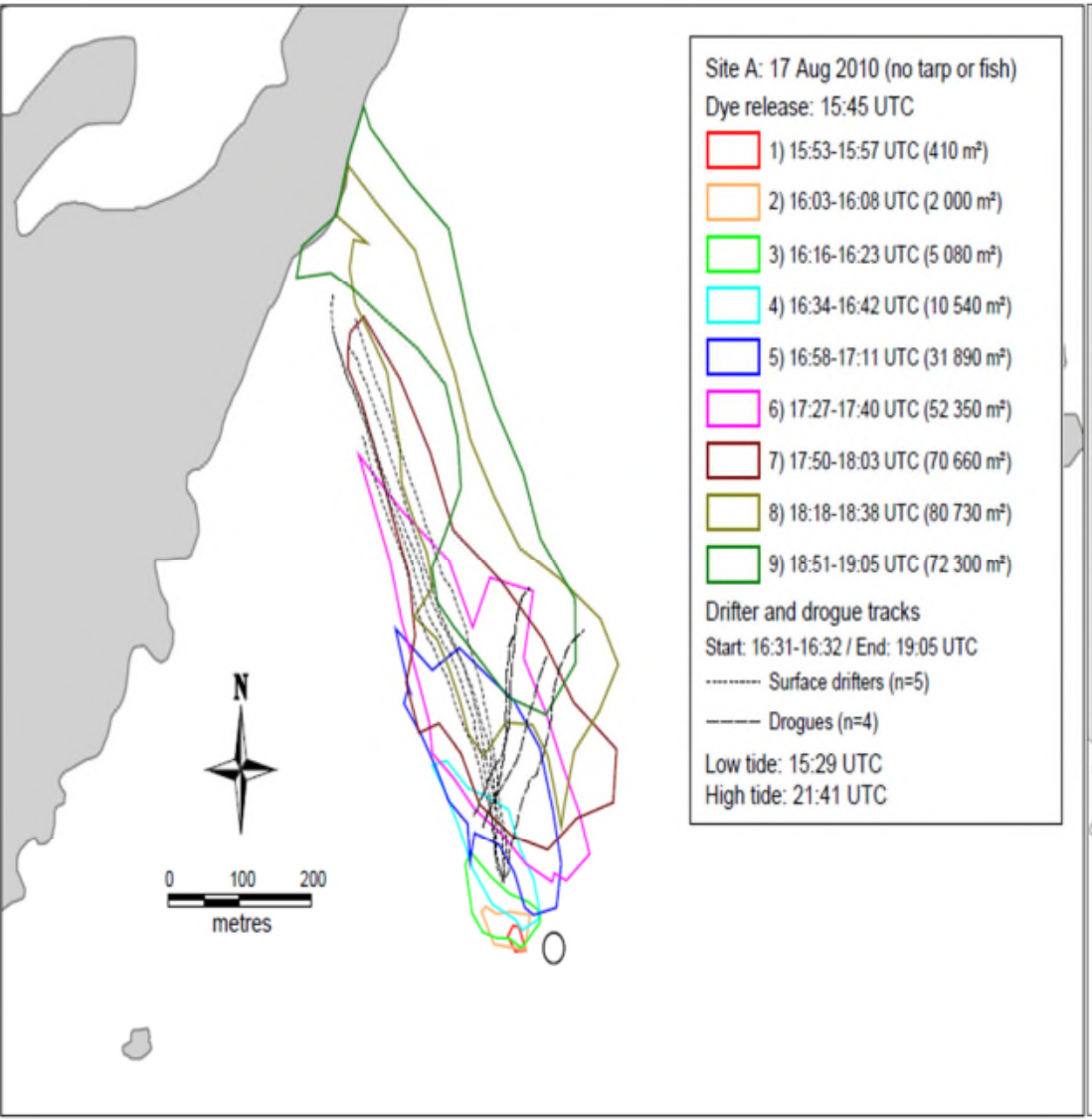
Marine Modelling/Bath Treatment Modelling

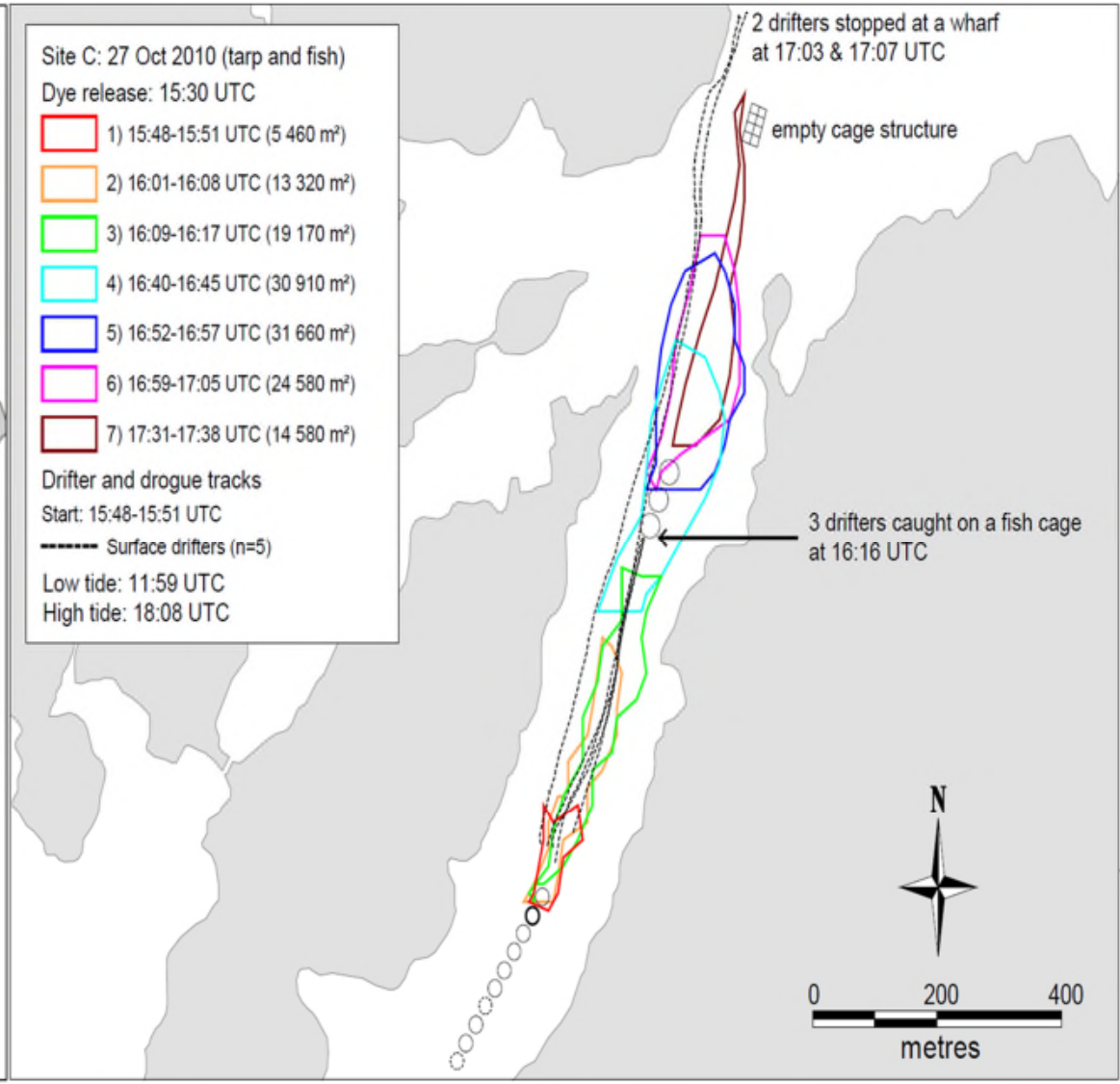
Marine Modelling/Bath Treatment Modelling





Marine Modelling/Bath Treatment Modelling

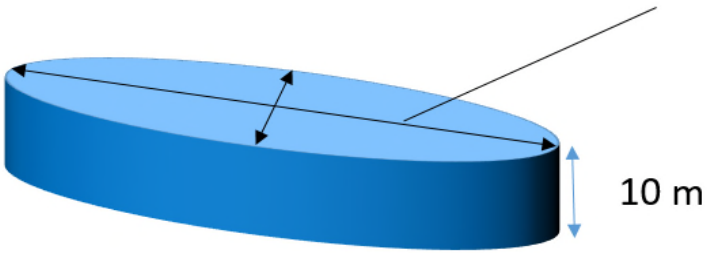




Bath Treatment Modelling - Simple Approach

Simple Ellipse Calculation From Mean Current Speed

3 Hr Ellipse - Azamethiphos

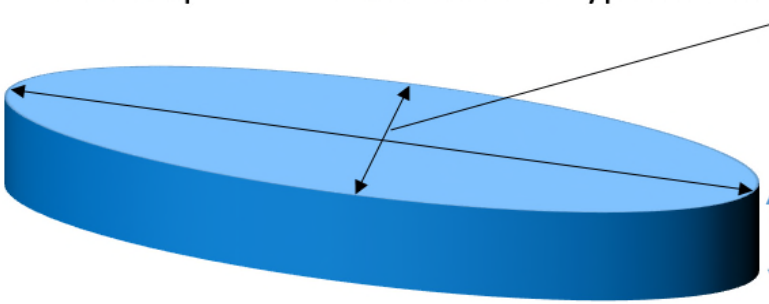


Length Controlled by Mean Current Speed

10 m

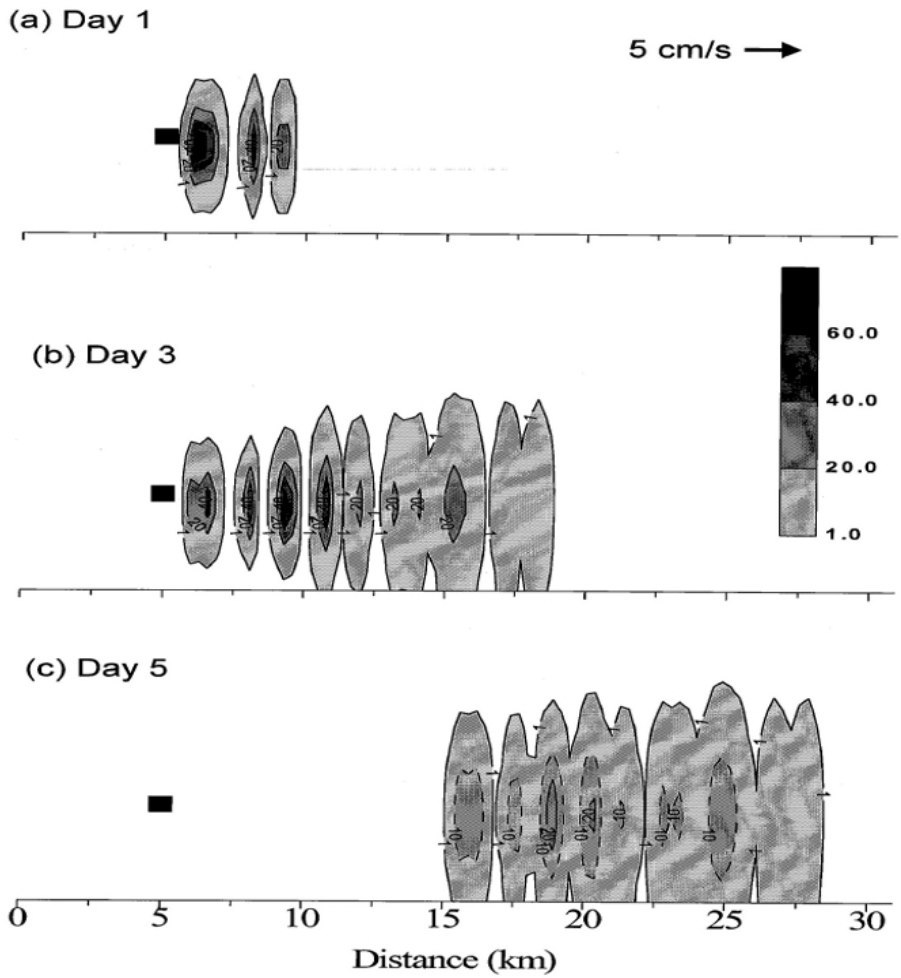
Width is a Conservative Assessment of Plume Spread

6 Hr Ellipse – Deltamethrin & Cypermethrin

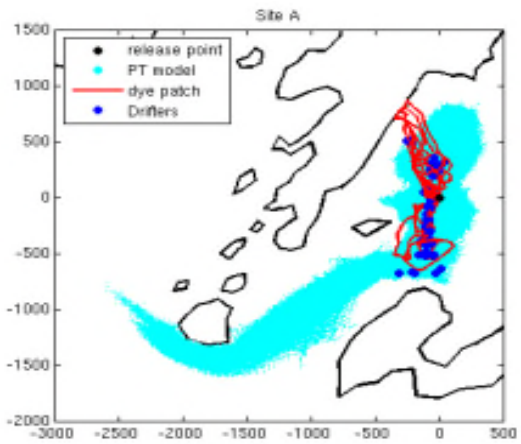


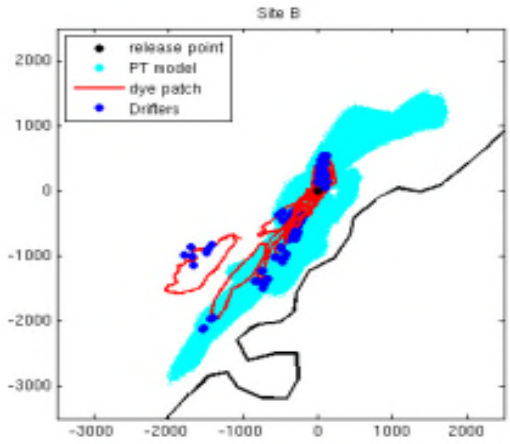
10 m

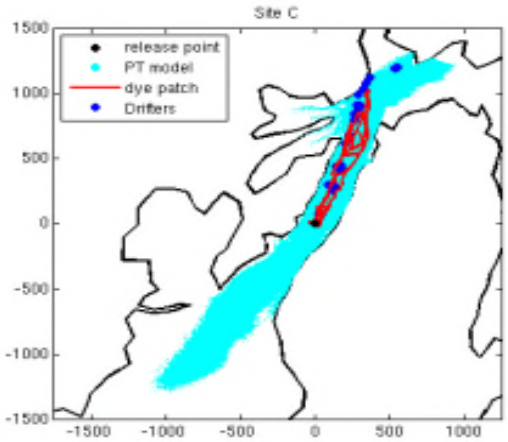
72 Hour Model - Azamethiphos



Marine Modelling/Bath Treatment Modelling



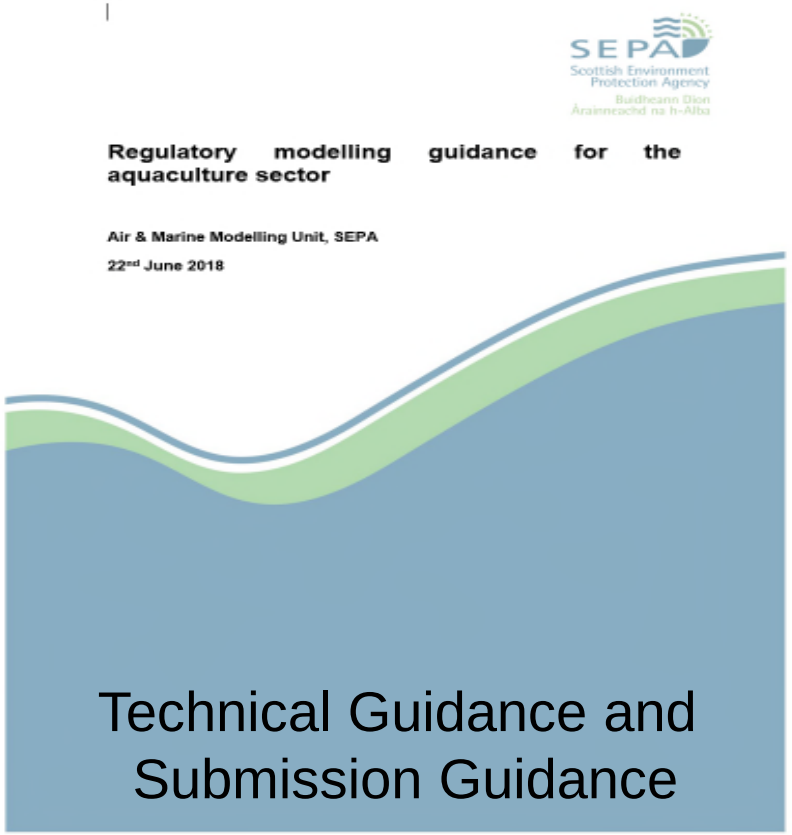




- Single Dye Releases Challenging To Model.
- Models May Be Used To Determine Total Area of Potential Exposure.
- Smaller Scale Dye Releases Likely To Be Required To Check Marine Model.
- Be Mindful of Lead Time For Dye Release Permission from Marine Scotland (10 To 12 Weeks).

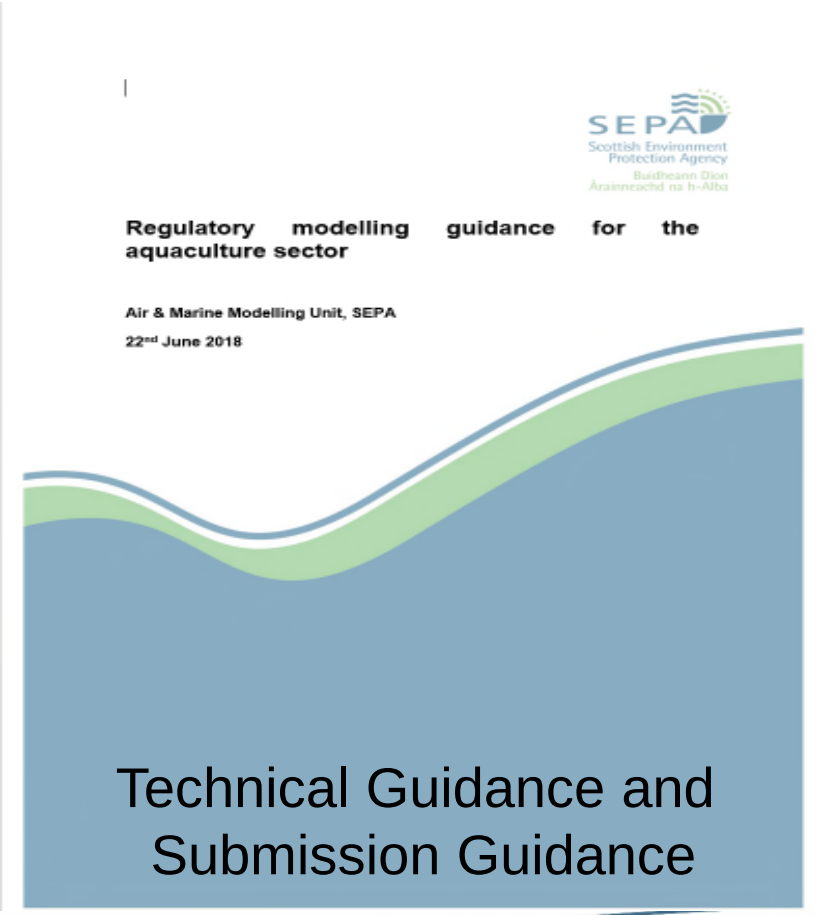
Modelling Requirements - Depomod

- Depomod
  - Driven By 90 Days Of Current Meter Data.
  - Default Risk Assessment Settings.
  - Can Be Compared Against Existing Monitoring.
  - Modelling Checked At Pre-Application Stage.
- Key Outputs
  - Assess Likelihood of Mixing Zone Compliance.
  - In-Feed Chemical Permit Limits.
  - Provides Baseline Survey Guide.
- Issue
  - Model performance issues in Complex Areas.

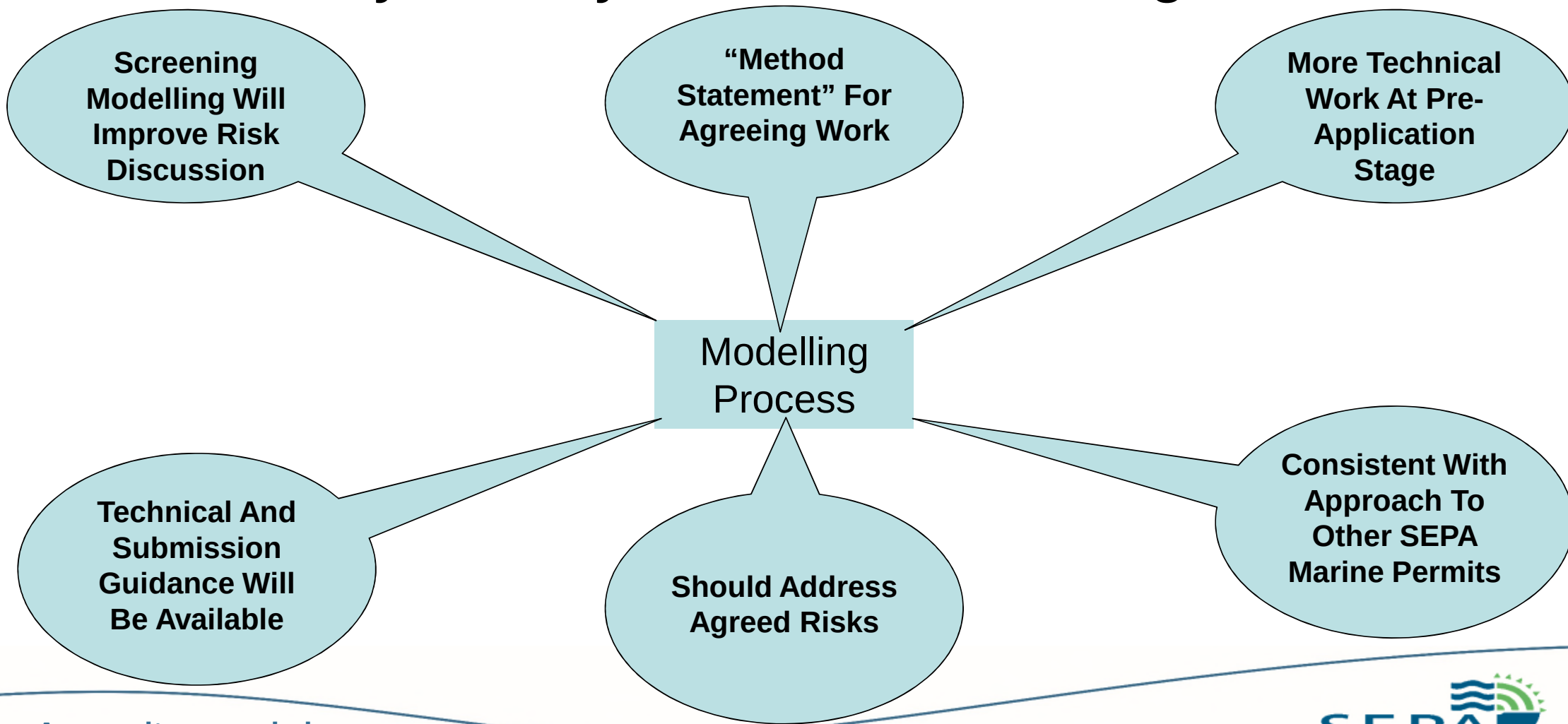


Modelling Requirements – Marine Modelling

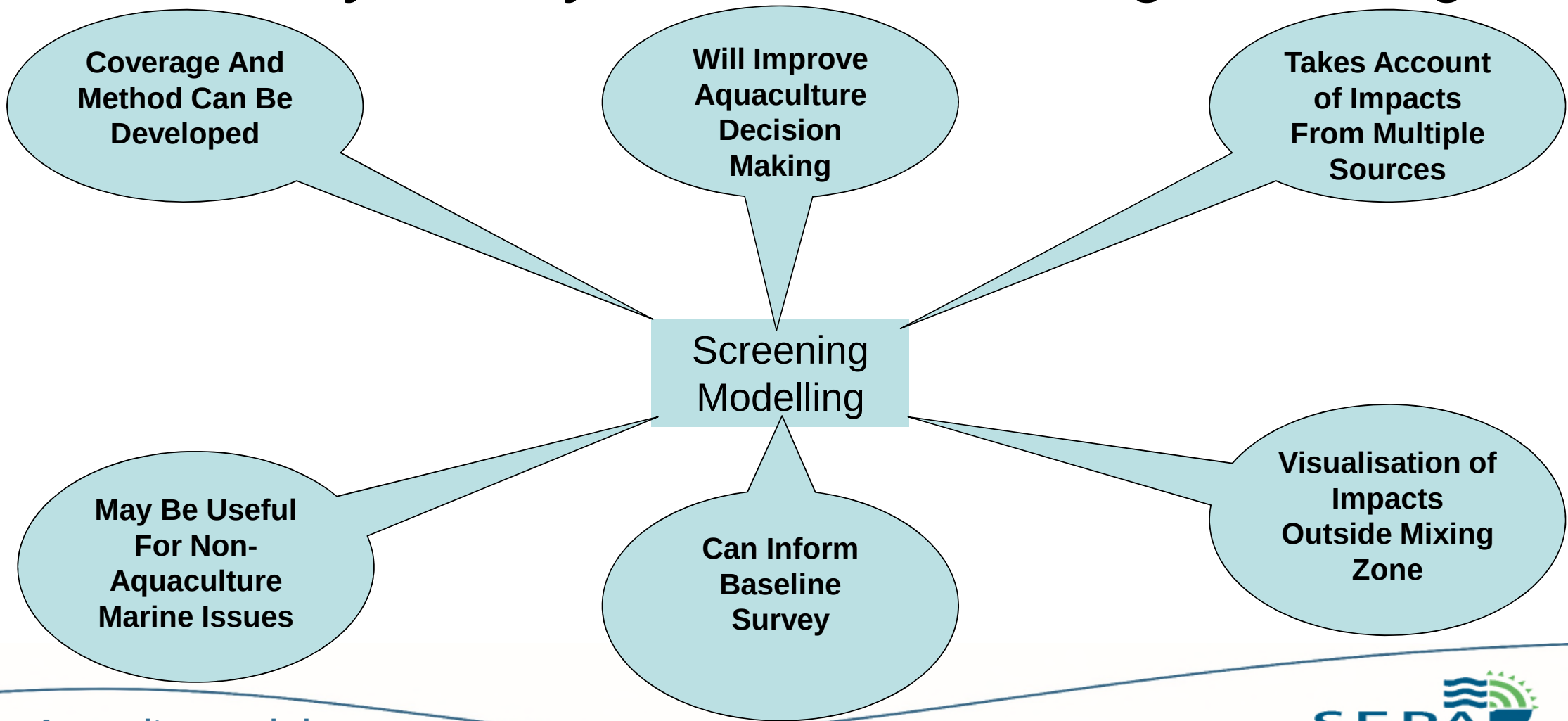
- Marine Modelling
  - More Detailed Version of Screening Modelling.
  - Generally Required For All Applications.
  - Exceptions Possible For Low Risk Proposals.
  - Complexity Appropriate To Risk.
- Key Outputs
  - Cumulative Impact Information.
  - Impact on Features of Interest.
  - Bath Chemical Permit Limits.



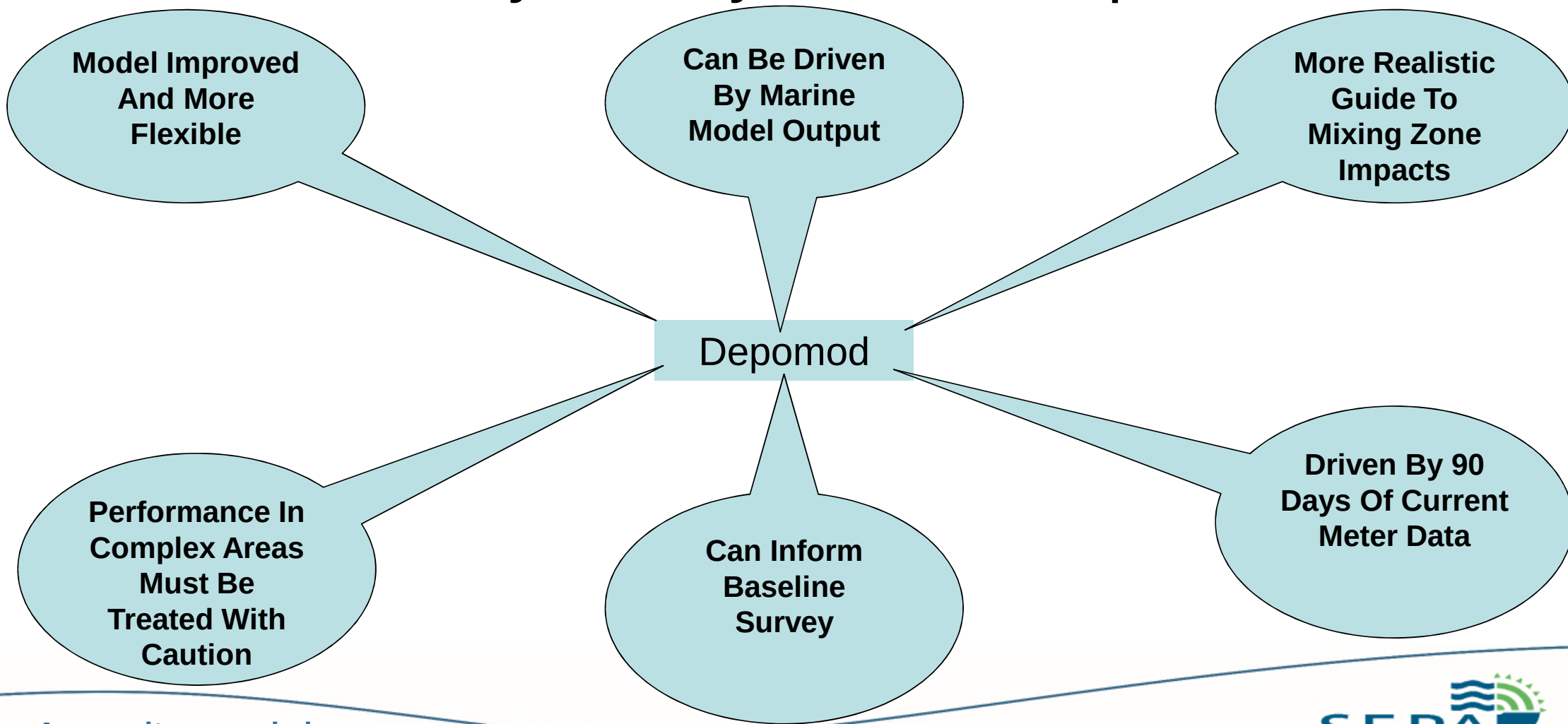
Summary Of Key Points – Modelling Process



Summary Of Key Points – Screening Modelling



Summary Of Key Points - Depomod



Summary Of Key Points – Marine Modelling